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ABSTRACT

The material in this unit is intended to provide upper elementary students with basic information about: (1) what energy is, (2) where it comes from, (3) how we use it, and (4) ways we can more wisely use the energy available to us. By the completion of the study of this unit, a student should be well aware that any life style is closely related to the amount of energy available and being consumed. Objectives are listed in front of the unit followed by a cross-reference relating the objectives to the appropriate activities. Maps, charts, graphs, short articles, special activities, and other materials referred to in the various activities are included in the appendix. (JP)

environmental education curriculum

ENVIRONMENTAL EDUCATION PROJECT
ESEA TITLE III, SECTION 306

Topeka Public and Parochial Schools
1601 Van Buren, Topeka, Kansas 66612
Phone: 913-232-9374

This rough draft was developed by the Environmental Education Project Staff, January 1974, for intermediate-level elementary school students.

Donald French, Project Coordinator
Robert King, Program Specialist - Secondary
Glenn Clarkson, Program Specialist - Elementary
Thad Whiteaker, Program Specialist - Special Education

ENERGY

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ENERGY

Foreword

Our present life style means all of us are consuming more energy than ever before. This increasing demand by individual Americans for energy, increasing populations, and citizens of other countries wishing to improve their standard of living have created greater demands for energy than our present technology can supply. Current energy problems have caused people to become concerned with what energy is and where it comes from. People were not concerned as long as they received the supply of electricity, gasoline, natural gas, and other energy supplies.

The material in this unit is intended to provide upper elementary students with basic information about: 1) what energy is, 2) where it comes from, 3) how we use it, 4) and ways we can more wisely use the energy available to us. By the completion of the study of this unit, students should be well aware that any life style is closely related to the amount of energy available and being consumed. As part of this unit, students will visit displays in the State Historical Society Building where they will compare energy usage with various life styles.

Accurate data concerning energy resources and usage is hard to obtain due to conflicting reports and methods for computing the information, and to the interests of groups doing the research. The facts used in this unit are intended to reflect generalities and are as accurate as possible from the information available at the time the unit was developed. Undoubtedly students will locate conflicting data in various magazines and other sources. This conflicting information can be used to point out the importance of critical reading, and the importance of determining the source of information.

To facilitate use of the material, objectives are listed in front of the unit followed by a cross reference chart relating the objectives to the appropriate activities. Maps, charts, graphs, short articles, special activities, and other materials referred to in the various activities are located in the appendix.

Teachers are not expected to utilize all activities, but should select those appropriate for their students that will accomplish the unit objectives. Feel free to modify or substitute activities as necessary to obtain the best education possible.

Glenn Clarkson
Glenn Clarkson
Elementary Program Specialist

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Donald French

Donald French
Project Coordinator

TABLE OF CONTENTS

UNIT GOALS AND OBJECTIVES

Goals:

1) To develop an understanding of the basic vocabulary used in discussing energy and its usage.

2) To develop an understanding of our energy sources and the supply of each.

3) To develop an awareness of the increasing demands for energy.

4) To increase an awareness of the individual's responsibility in conserving our energy resources.

5) To develop an awareness of ways by which individuals, businesses, industry, and others can reduce their demands for energy without adversely affecting life styles.

Cognitive Objectives:

Following the study of this unit, students will be able, on multiple-choice questions, to select a choice:

1) ...indicating that they realize that heat, light, and electricity are all forms of energy.

2) ...match any or all of BTU, calorie, and kilowatt-hour with ways we measure energy.

3) ...indicate they understand that the energy in food originally comes from the sun.

4) ...will select home heating system as the greatest user of energy within the home.

5) ...will select gravitational energy as the form of energy that moves things like sleds down hills.

6) ...will select industry as the greatest consumer of energy in our society.

7) ...will indicate that more energy is required to make aluminum containers than is required for making containers from other common materials.

8) ...will select a choice indicating they understand items such as electric toothbrushes require much more energy for their manufacturing than for their operating.

9) ...will select buses as the method of travel between cities that requires the least energy per mile a person travels.

10) ...will select pipelines as the method requiring the least energy to move liquids over great distances.

11) ...will be able to identify the sources of fossil fuel energy.

12) ... will be able to identify the major sources of energy being presently used in the United States.

Cognitive Objectives (Continued)

13) ...will select nuclear fuel as a likely source for much of our energy 50 years from now based on present projections.

14) ...will select coal as the form in which the United States has the greatest supply of stored energy.

15) ...will select a choice indicating they understand that energy is changed from one form to another in electrical generating stations.

16) ...will select a choice indicating we change our energy supply from one form to another to make the energy easier to transport and use.

17) ...will select an item not made from crude oil from a list of items made from crude oil.

18) ...will select a choice indicating that as people develop more industry, knowledge, and become richer they use more energy.

19) ...will identify increasing population, changing life styles, and decreasing of our present sources of energy as causes for the energy crisis.

20) ...will select a choice indicating that as we continue to use more energy pollution will continue to be a problem.

21) ...will select making throw-away containers as one way energy is wasted by industry.

22) ...will select requiring pollution control devises as the best way to control pollution without damaging our economy.

Affective Goals:

Following the study of this unit, students will reflect a positive attitude toward the following concepts:

1) Individuals should not waste energy.

2) Individuals should buy the most energy efficient products.

3) Pollution from energy production and usage must be controlled even if it requires using more energy.

4) U. S. citizens must become more aware of the sources of energy and the amount of each source available.

5) The use of energy should be regulated by laws.

6) Energy usage should be regulated by changing its costs.

7) We should be concerned about the energy resources for future generations.

ACTIVITY SUMMARY SHEET

TOPIC I

Activity Number	Topic	Behavioral Objectives the Topic Helps Develop
1.0	Introduction	
1.1	Determining What Students Thing Energy Is	1
1.2	Cassette Tape on "Our Energy Supply"	11, 12, 13, 14, 18, 20
1.3	Collage - Energy Forms and Uses	Variable
1.4	Develop a Working Definition of Energy	1
1.5	Measuring Energy	2

TOPIC II

2.0	Introduction	
2.1	Energy Used by Our Bodies	3
2.2	Home Use of Energy	1, 2, 4, 16, 12
2.3	Graphing Home Energy Use	4
2.4	Recreational Use of Energy	1, 5
2.5	Business Use of Energy	1
2.6	Industrial Use of Energy	6
2.7	Energy for Transportation	9, 10
2.8	Distribution of Energy Used in Transportation	9, 10
2.9	How the United States Uses Energy	6

TOPIC III

3.0	Introduction	
3.1	Body Energy	3
3.2	Source of Fossil Fuel Energy	11, 12
3.3	Location of Fossil Fuel Supplies	11, 12
3.4	World Supply of Fossil Fuel Energy	11, 12
3.5	World Distribution of Coal, Oil, and Gas	11, 12
3.6	Present Energy Sources - United States	12
3.7	Amounts of Fossil Fuel Remaining	11, 12, 14, 16
3.8	Other Sources of Energy	12
3.9	Changing Energy Usage in the United States	18
3.10	Film - "We Use Power"	12, 13, 14, 15, 18, 19

TOPIC IV

4.0	Introduction	
4.1	Generating Electricity	15, 16
4.2	Changing Electrical Energy into Motion Energy	1, 16
4.3	Changing Electrical Energy into Heat and Light	1, 16
4.4	Changing Gasoline (Chemical Energy) into Motion Energy	1, 16
4.5	Converting Crude Oil into Usable Energy Forms	16, 17

ACTIVITIES SUMMARY SHEET
(Continued)

Activity Number	Topic	Behavioral Objectives the Topic Helps Develop
	TOPIC V	
5.0	Introduction	
5.1	Why Be Concerned About Saving Energy	19
5.2	Conserve Energy in the Home	4
5.3	Conserving Transportation Energy	9, 10
5.4	Reducing Industrial Energy Usage	6, 7, 8, 21
5.5	Allocation of Natural Resources	12
5.6	Developing an Energy Ethic	Variable
	TOPIC VI	
6.0	Introduction	
6.1	Enerby Usage and Health	20
6.2	Sources of Air Pollution Relating to Energy Usage	18, 19, 20
6.3	Problems Associated with Extracting Fuels from the Earth	20, 22
6.4	Control of Environmental Problems Resulting from Energy Usage	22
	TOPIC VII	
7.0	Introduction	
7.1	Trip Preparation	
7.2	Field Trip Leader Directions	
7.3	Field Trip Follow-up	

Suggested Time Line for Unit Activities

Day

Before the field trip:

X	(A) Arrange the field trip date with the Environmental Education project staff and/or Historical Society volunteers as early as possible.
	(B) Obtain approval of the field trip date from your building principal.
	(C) Submit field trip request to your principal (See Appendix E).
	(D) Contact the Environmental Education project office concerning the student pretest before teaching any of the unit.
	(E) Arrange for the tape "Our Energy Supply" from the Environmental Education project office.
	(F) Arrange with your media center to use the film "We Use Power."
X to 0	Teach the activities that precede the field trip which you feel are useful and will enable you to meet the unit objectives.
7	Prepare copies of the letter informing parents about the field trip (Samples in Appendix E).
6	Send parent letters home and invite the principal to participate in the field trip.
3	Make copies of the data sheets for students as directed in Appendix E.
1	Go over the data sheet with students. If signed parent permission is required, check to see all are returned.

Field Trip:

0	(A) Using masking tape, make name tags for each student.
	(B) See that each student has a pencil or ball-point pen, a clipboard or notebook, and the data sheets.
	(C) Have students use the restroom before leaving school.
	(D) Have the students divided into 2 or 3 groups as agreed on with the leaders of the time your trip was scheduled.
	(E) Have students ready to leave at the agreed time.

Following the Field Trip:

-1	Discuss data sheets and field trip observations. Use the teacher guide for field trip discussion (Appendis E) to help direct the classroom follow-up.
-1 to -X	Teach any remaining activities you feel are useful and will help meet the unit objectives.
	Contact the project office to obtain posttesting materials and teacher feedback forms.

E N E R G Y

1.0
Introduction

1.0
Students normally have trouble understanding or relating to the standard definition of energy which is "the ability to do work." For this reason, it will be worthwhile to have the class do some activities that will lead them into a common understanding and working definition of energy. By the end of this series of activities, students should realize that energy is used any time movement, change, force, work, or heat is involved. Energy is the "stuff" that allows or causes the change, force, work, movement or heat. Energy cannot be seen, but we can see or feel the results of energy being used.

Students will often use the word "power" in describing energy. When studying this unit interchanging the word power and energy will not create any real problem. However; it would be best if the students realize by the end of the unit that there is a difference between energy and power. Power is the rate at which energy is being used. The more power something has the more energy it is using.

NOTE: Refers to Appendix A for supplemental activities to reinforce all topic activities. It includes energy problems, scramblers, discussion topics, and special student projects.

1.1
Determining What Students Think Energy Is

1.1
Allowing students to discuss what they think the word energy means can provide the teacher with considerable input as to the knowledge of the students. Do not spend much time at this point discussing energy problems, but keep the discussion on their impressions of what energy is. It will be helpful if you write words or phrases on the board representing the various student thoughts. End this activity with students realizing that energy is a broad topic and that people have different views as to what energy is. Be working toward an understanding that energy exists in many forms and is involved in all work and activity.

1.2
Cassette Tape On "Our Energy Supply"

1.2
The tape "Our Energy Supply" produced by Bell and Howell as part of The Only World We Have Series is available from the Environmental Education project office. The tape is about twenty minutes long and deals with the energy problem and possible future solutions. The tape can serve as an introduction to why we are concerned about energy. It broadly covers a lot of material, but does not deal with anything in depth.

Sample questions are provided in Appendix D to assist in directing class discussion during and following the tape. You may wish to make the tape available for listening by individual students or small groups.

1.3
Collage of Energy Forms and Uses

1.3
Have the students bring pictures illustrating examples of energy, ways it is used, and different forms of energy. Use these pictures to construct a bulletin board collage with the word "Energy" in the center. As students put up their pictures, have them explain to others how the pictures relate to energy. Hopefully the variety of pictures will include every facet of our life, since energy is involved everywhere. At this point, it will be interesting to see if any student includes the sun and realize it is the original source of all forms of energy. Do the pictures illustrate energy used by living organisms as well as energy used by non-living things in our world?

Continue to develop the energy picture collage until all students realize that no part of their life can exist without energy. Use the pictures to illustrate how energy is changed from one form to another. For example: sun's light to green plants to coal to heat to electricity to light. Students may wish to bring additional pictures or rearrange pictures to illustrate stories within the energy collage.

1.4
Develop a Working Definition of Energy

1.4
Following activities 1.1 - 1.3 students should be ready to agree on a definition of energy. They should develop a definition that is meaningful to them and describes the way they perceive energy. The following samples of textbook definitions for energy may provide guidelines for you in directing the students as they develop their definitions:

a) That which may be converted into work.
b) Something capable of performing work.
c) Capacity for doing work.
d) Capable of doing work.

Many students will not relate to these definitions so efforts should be made to cooperatively develop a meaningful definition. An example might be: The "stuff" that (1) allows us to think, work, and play; (2) makes heat; (3) makes machines run; (4) makes plants grow; (5) causes wind, rain, and other weather; and (6) causes the oceans and world to move.

1.5
Measuring Energy

1.5
Energy exists in many forms. It can be rather confusing to compare one form with another. For example, how much electrical energy or electricity does it take to equal the energy stored in one ton of coal?

1.5

When scientist compare various forms of energy they usually do it in terms of how much heat it can produce. There are four commonly used units. Scientist working in laboratories measure heat in small calories. A small calorie is the heat required to heat one gram of water one degree centigrade or put another way, it would take 20,817 small calories to heat one gallon of water from 60° to 70° F.

People working with food measure energy in large Calories. The large Calorie is 1,000 times larger than the small calorie. A typical twelve year old boy will use about 3,200 large Calories of energy each day just thinking, moving, keeping his body the right temperature and keeping all his internal organs going. Girls will use a little less, around 2,600 large Calories. These Calories of energy come from the food we eat.

People working in industry with coal, oil, natural gas, electricity, etc., usually measure energy in terms of Btu's (British Thermal Units). The Btu way of measuring energy was first developed by the British. One Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. One Btu is equal to 252 small calories. Air conditioners and furnaces are usually rated on their Btu capacity.

Today about one-fourth of the energy being used in the United States is in the form of electricity. Electrical energy is measured in kilowatt-hour. If you read the meter measuring the electricity coming into your home, the reading will be in kilowatt-hours. One kilowatt-hour is equal to 3,413 Btu's or 860,000 small calories.

The word kilowatt-hour can be divided. Kilo means 1,000 a watt is a unit of power or rate of using energy. Each electrical appliance has the watts required to power it printed on it. One kilowatt-hour means using one thousand watts for one hour of time. A 60 watt light bulb that is on for 12 hours would use 60 X 12 or 720 watt-hours or 0.720 kilowatt-hours of energy.

It is not important that students know the definition of calories, kilowatt-hours, or Btu's, but they should be aware that these are commonly used units for measuring energy. Have students see if they can find new articles, magazine articles, stories, or other samples of information where the terms Btu's, kilowatt-hours, or calories are used.

2.0 Introduction

2.0
The activities in this topic are intended to increase awareness of the many ways our lives are affected by the use of energy.

The supply of energy available to Americans in the past has been nearly limitless. This abundance of easy to get energy has caused us to be wasteful with our energy resources. Just like air, energy has always been available. Not until the air became polluted enough to cause sickness did people get concerned about our air supply. Now that our decreasing energy supply is causing limits on our lives, we are showing interest that our decreasing energy supply is causing limits on our lives, we are showing interest in the ways energy affects our lives. People are showing interest by expressing unhappiness toward the energy industry and political system and many people are trying to learn how they can carry on a meaningful life with less energy.

2.1 Energy Used By Our Bodies

2.1
The purpose of this activity is to get students to realize their bodies are consumers of energy and that energy enters the body in form of food.

Often energy is thought of as just the gasoline, natural gas, or electricity we buy. However; the food we buy contains the energy needed by our bodies in order to keep us alive, moving, thinking, and operating. Without this energy our bodies would not work, just like a light bulb would not work if its electrical energy was turned off.

Most students are aware that their body needs food and that this food keeps them going. The important thing students should do during this activity is to relate body activities with the concept of energy usage. Most students can do this through a class discussion. Have the students discuss ways their body uses the energy in food, which foods contain the most energy, and what type of body activities they think use the most energy. Some specific topics that can be used are: (1) how the body keeps warm and cool, (2) what do your muscles feel like when you force them to use energy faster than it is being supplied? (3) how does your body get the energy changed from food into muscle power? and (4) who requires more energy young or older people, boys or girls?

Some classes may gain a better understanding of our bodies use of energy by doing individual or small group research or one or more of the above questions.

2.2 Home Use Of Energy

2.2
By the end of this activity students should be able to indicate (1) types of energy sources coming into their homes, (2) twenty ways energy is used in the home, (3) which uses consume the most energy in the home, (4) which uses are most necessary, (4) forms of energy when being actually used, and (5) benefits they gain from this home use of energy.

A large amount of energy is used in our homes to make us more comfortable, for recreation, and to make our work easier. To increase student awareness of home uses of energy have each student take home and complete the "Home Use of Energy Check List" found in Appendix A. Students, with their parents assistance if desired, can complete the check list. Explain that you do not want names on the sheet. This should help get a more realistic answers on some of the questions. To help the students understand the sheet, fill one out using the school as the home having all students work together. This would be a good time to have your students tour the parts of their school that they do not normally visit. The rankings will vary with each persons opinion. Reasons for rankings could lead to a very interesting and worthwhile discussion after the check list is completed.

After the check lists are completed use them to discuss the following: (1) How is energy used in our homes? (2) In what form(s) is energy entering your home? (3) What forms is the energy changed into within the home? (4) What uses in the home consume the most energy? (5) How does the home uses of energy benefit us? and (6) Which of these uses could we do without?

2.3 Graphing Home Energy Use

2.3
Appendix B contains a Home Energy Usage graph illustrating the average percentages of energy used for various purposes. This will reinforce the discussion at the end of Activity 2.2. Give special emphasis to the large amount of energy used for heating. Point out this will vary some from home to home, but represents the average home in the United States.

2.4 Recreational Use Of Energy

2.4
In the United States recreation has become a large industry consuming energy just like other activities. At the end of this activity, students should be able to name ten types of recreation and describe the form(s) of energy it requires. Student awareness of recreations use of energy can be increased by having students compile a list of recreational activities including the forms of energy needed for the activity. For example: Basketball - body energy of players, light energy for illuminating the building, heat energy to warm the buildings or sailing - wind energy to move the boat, chemical energy in gasoline for traveling to the lake, and body energy to guide the boat.

2.4
Recreational Use
Of Energy
(Continued)

2.4
After the students have compiled the list of recreational activities and forms of energy each uses, have the students place the activities in energy groups; such as, Group I uses mostly body energy, Group II uses mostly electrical energy, Group III uses mostly chemical energy (gasoline), Group IV uses other forms of energy (wind, gravity, etc). Identify activities requiring forms of energy that are becoming hard to find or obtain?

2.5
Business Use
Of Energy

2.5
By the end of this activity students will be aware that the heating of buildings used for businesses consume a large amount of energy. The many stores, offices, services stations, and other business buildings consume a good size portion of our nation's energy. Their needs in many cases are similar to home needs such as heating. Other energy needs they have might include computer operating, advertising, and elevator operating.

Use the business energy usage graph found in Appendix B to illustrate the major ways business consumes energy. Have the students think of energy consuming activities of business that fit into the "other" category.

2.6
Industrial Use
Of Energy

2.6
Nearly one-half of the energy used in the United States is consumed by industry in the processes of making materials and equipment. By the end of this activity, students will realize industry is the biggest consumer of energy, a lot of energy is consumed to make materials and equipment, and often it takes more energy to make an item than the item will ever use during its operation.

Use questions to direct a discussion bringing out the following information: Very few people think about the amount of energy required to manufacture an item, and most people think only about how much energy the items uses in its daily application. For example: a lot of energy is required by industry to make an electric knife. Think about all the steps from raw material to the finished product that use energy. Most home appliances are made of plastic, iron, and aluminum. Extracting aluminum from its ore requires seven percent of our nations energy. Iron must be extracted from ore, melted and shaped. Plastics are processed from oil and coal. Every step in the manufacturing process consumes energy. Have the students do research on the steps involved in getting something from the natural resources to the finished product. Some examples that could be used are: making a cotton dress, making nylon shirts, making of plastic toys, making of a bicycle, and making of synthetic rubber tires.

2.7

Nearly one-fourth of our nations energy is used in moving people and materials from one location to another. Students should be able to name six ways people and material are transported and which of these ways are most efficient.

As student name means of transportation, list them on the chalkboard. The list might include: Buses, trains, animals, cars, boats, trucks, airplanes, walking, bicycles, and motorcycles.

Ask which means of transportation can move the most material using the least energy? (Trains) Which can move the most people for the least energy? (Buses)

The following data will help explain the amount of energy required for moving people by different means. Information is taken from material supplied by the Oak Ridge National Laboratory.

Amount Of Energy Used To Transport People

Method of Transportation Method of Transportation	Btu's of Energy Consumed to Move 1 Passenger 1 Mile Between Cities	Btu's of Energy Consumed to Move 1 Passenger 1 Mile in a City
Buses	1600	3700
Trains	2900	-
Cars	3400	8100
Airplanes	8400	-
Bicycle	-	200
Walking	-	300

The following data will help in discussing the energy used in moving freight.

Amount Of Energy Used To Transport Freight

Method of Transportation	Btu's Required to Move 1 Ton 1 Mile
Pipeline	450
Railroad	670
Waterway	680
Truck	3,800
Airplane	42,000

2.8 Distribution Of Energy Used In Transportation	2.8 The transportation energy usage graph, Appendix B, illustrates the major ways energy is used in transportation. Combining this graph with the data in 2.7 should develop meaningful student discussion. After observing and discussing this graph students should realize that our greatest amount of transportation energy is used for moving people.
2.9 How The United States Uses Energy	2.9 After viewing the graph illustrating the ways the United States uses its energy, Appendix B, students should be able to name the four major catagories of energy usage and rank them according to their amount used. This graph can be used to summarize the four previous energy usage graphs. <u>Be sure to bring out that these graphs did not include the energy used by our bodies.</u>

3.0 Introduction

3.0
By the time we use energy it has usually been changed from its original form--for instance coal into electricity. The intent of this topic is to increase awareness of our sources of energy and the relative amount of energy we obtain from each source.

3.1 Body Energy

3.1
The energy that keeps each of our bodies operating comes from the food we eat. How does it get there? By the end of this activity students should realize all energy used in their body originally comes from the sun, and that this energy gets to us from plants and animals we eat.

If students have worked with food chains, a short review of food chains and energy paths will help remind them of how energy gets from the sun to us. Students can gain a basic understanding of how their body gets its energy by following the sample energy path illustrated in Appendix A. In discussing the energy path illustration, emphasize: (1) only the green plant has the ability to combine minerals from the soil, water from the soil, carbon dioxide from the air, and light energy from the sun into what we call food (a process called photosynthesis); (2) food is matter and energy combined that when eaten by animals releases some of its stored "chemical" energy for the animal to use: (3) animals cannot obtain any energy except by eating food and then releasing the chemical energy of take food within their bodies; (4) when one animal eats another animal it is able to release some of the energy still contained in the first animal's body; (5) the further down a food chain an organism is the less energy available to it, thus; man has the most energy available to him if he eats mostly green plants. (This has many interesting implications.); and (6) once energy is used by an organism, the same energy cannot be used by any other organism.

3.2 Source Of Fossil Fuel Energy

3.2
Nearly all of the energy used in industry, business, and our homes comes from coal, oil, or natural gas. These sources are grouped together as fossil fuels, because they all result from past living organisms. By the end of this activity, students should be able to briefly explain how coal, oil, and natural gas are formed.

Most students enjoy doing research on how coal, oil, and natural gas are formed. Have students report their findings to the class. Some important points that should be included are: (1) the energy contained in these fossil fuels originally came from the sun and was first captured by green plants, (2) this stored energy was collected many thousands of years ago, and (3) we are using up these fossil fuel supplies faster than they are being formed.

3.3 Location Of Fossil Fuel Supplies	3.3 By the end of this activity, students should realize that fossil fuel energy deposits are not evenly distributed over the earth's surface. They should also be able to give the names of a few areas in the United States where oil, natural gas, and coal are found in rather abundant supply. The locations can be illustrated with the three United States maps (coal, oil, natural gas) found in Appendix B. The maps can be used as student handouts, or as an overhead projection for discussion.
3.4 World Supply Of Fossil Fuel Energy	3.4 By using the world fossil fuel supply graph (Appendix B) students will realize that our biggest source of fossil fuel energy is coal. As students are studying this graph, have them think about some of the problems associated with using energy from coal. For example: strip mining, air pollution, fly ash, transporting the coal to power plants or industries, deep underground mining, reclaiming mined-over land, using the supply faster than it is replaced and etc.
3.5 World Distribution Of Coal, Oil, And Natural Gas	3.5 After studying the graph and maps illustrating the world supply and distribution of fossil fuels , the graph illustrating world distribution of coal, natural gas, and oil can be used as a review and to gain better understanding of which countries control the present world energy supply. Bring out the fact that the United States is presently using about 35 percent of the world's energy. This will cause us to use up our energy supply before other countries, or we must buy energy from other countries. This is one reason we want to buy the oil from the Middle East. Another interesting fact to bring out is that only six percent of the world's population lives in the United States. So approximately six percent of the world's people are consuming over one-third of the daily used energy. It would be impossible for all the people of the world to use as much energy per person as we do using our present energy sources of mostly coal, oil, and natural gas.
3.6 Present Energy Sources - United States	3.6 Energy used in the United States comes from six different sources. The three fossil fuels, coal, oil, and natural gas, produce over 95 percent of this energy supply. By the end of this activity, students should know the three primary sources of our present energy supply and predict which of these forms of energy will be providing a greater portion of our energy in the next twenty years.

3.6
Present Energy Sources - United States (Continued)

3.6
Place the following information on the chalkboard:

United States Energy Sources 1973

Coal	20.1%	fossil fuels
Petroleum	39.6%	fossil fuels
Natural Gas	35.6%	fossil fuels
Hydroelectric Power (Dams)	4.0%	
Nuclear Power	0.6%	
Geothermal Power	less than 0.1%	

Are fossil fuel energy sources being used proportional to the world supply available. Based on the world supply, which fossil fuel do you expect us to use more of in the future? Which of the non-fossil fuel energy sources do you expect to see increased? Why?

3.7
Amounts Of Fossil Fuels Still Remaining

3.7
Following this activity students should be able to indicate which of the fossil fuels we have remaining in greatest supply, when each type is predicted to be depleted, and the relative percentage of the original supply we have already used.

Use the United States fossil energy usage and supply graph, (Appendix E) to direct a class discussion. Review what a graph of this type means. Be sure the students understand the darkened area is the amount used up and the light area is the supply still available.

Discussion Topics:

(1) When a fuel source is first used the demand for it and the technology for obtaining it is low.
(2) As demand grows and means of obtaining it improves, more and more fuel is required.
(3) Once the "easy to get" fuel supply is gone more technology and expense are required to obtain the remaining supply.
(4) This pattern has been true for all fossil fuels.

3.8
Other Sources
Of Energy

3.8
Nearly all of the world's energy supply has come from the fossil fuels. Today, our supplies of fossil fuels are getting depleted and what is remaining is harder to obtain from the earth. Other sources of energy, such as hydropower (water), geothermal, and wind, have been used to limited degrees. Still other sources are just being developed or considered as replacements for the fossil fuels. By the end of this activity, students should be able to name four possible sources of energy other than the fossil fuels.

Appendix C contains a series of short articles describing some of the alternate energy sources. It is suggested that individual or several students be assigned the task of using the articles and any other information they can obtain on a given energy source to explain the energy source to the class. Students should not be expected to become "experts" on these possible energy sources. These five questions might serve as guides for the student reports. (1) What is the source of this energy? (2) How is the energy trapped by man? (3) Where is this energy source located? (4) Does it have the potential of being a large source of energy? (5) What are some of the problems in using this source of energy?

The short articles in Appendix C describe hydropower, nuclear energy, energy from waste, solar energy, geothermal power, tidal power, wind power, and oil shale which is not a new type of energy but rather a new source for oil, a fossil fuel.

3.9
Changing Energy Usage
In The United States

3.9
The data showing United States energy usage, Appendix A, will provide the students another way to look at the energy trends in the United States. This data can be used for a graphing exercise.

Several interesting questions can be used to direct discussion after graphs are constructed. For example: (1) Why has the amount of energy from water power not increased any more? (2) Why did the total energy usage go down during the early 1930's? (3) Why are we not using more coal since we have a large reserve of it compared to oil and gas? (4) Which kind of fuel usage is increasing fastests? and (5) What advantages are there to using natural gas and oil over coal?

3.10
Film "We Use Power"

3.10
This film views the various types of power used today compared to the power available in the past. Power from muscles, water, fire, gasoline, steam, electricity, and the atom are briefly illustrated or discussed. A large portion of the film is devoted to electricity, its generation and uses.

This film can serve as a transition between studying where our energy comes from to how we use energy. A short summary and set of discussion questions about this film is included in Appendix D.

4.0 Introduction	4.0 This topic will briefly look at the process involved in converting the raw energy into usable forms. Converting our raw energy into forms of energy or power that we can use in our daily lives is an energy expensive, but necessary process. For example; around two-thirds of the energy in coal is lost when coal is converted to electricity. Today, we use most of our energy in the form of either electricity, fuel for heat, or fuel for engines. Neither electricity or engine fuel is found naturally on the earth.
4.1 Generating Electricity	4.1 By the end of this activity students should be able to name the three major parts of an electric generating plant, give the primary function of each, and know why we generate electricity. All electric generating plants operate basically the same, regardless of their fuel supply. All require a fuel, a turbine, and a generator. The fuel acts as the power source to turn the turbine, the turbine converts the power of the fuel into circular motion, and the circular motion turns the generator which produces the electricity. Use the diagram of a simple generator, Appendix A, as the basis for discussion with students. The first step in the diagram illustrates fuel producing heat that changes water into steam. The fuel can be oil, coal, natural gas, wood, or radioactive elements. As the steam is produced, it causes pressure. This steam pressure is allowed to pass over the fan like blades on a turbine. This causes the turbine shaft to turn. Connected to the end of the turbine is the generator. The generator consists of a magnet inside a coil of wire. As the magnet is moved inside the coiled wire, electricity is produced in the coiled wire. More wires are connected to the coiled wires of the generator to carry the newly produced electricity to our homes, industries, and businesses. In hydroelectric generating plants, the gravity pulls the water over the turbine blades causing them to turn the same as steam.

.1
enerating Electricity
(Continued)

4.1
Over the last 50 years, the efficiency of electric generators has constantly improved. Today, a good generating station can covert about 35 - 40 percent of the energy in coal into electrical energy. The following data will help students realize how generating plants have improved. Students may wish to graph this data.

Year	Approximate Cost for Each KWH of Electricity Produced
1924	15 cents
1926	12 cents
1928	8 cents
1930	5.5 cents
1932	5 cents
1934	4.5 cents
1936	4.25 cents
1938	4 cents
1940	3.9 cents
1972	2.25 cents

This data illustrates the rapid improvement in efficiency during the early years of electrical production. Also, bring out that during this same time period most things were increasing in value but the cost of electricity was decreasing. However, electrical producing companies now feel the cost for electricity will beginning increasing and the increase will continue indefinitely. Hard to obtain fuels and the need for more pollution control devices account for these expected increases.

Why do we generate electricity? Electricity itself is not a useful form of energy in our daily lives. Have the students think about the "real" form of energy they use in their lives. They use heat energy to keep warm, they use motion energy to move themselves and machines, and they use light energy to see by. Do we use any other forms of energy?

The next question to think about is what is the "best" way to get the energy from its raw source into the places and forms for our usage. The answer for this question can often be electricity and for this reason, we convert a large portion of our energy first into electricity then into its final used form. Some coal and natural gas is used directly for producing heat energy in our homes. Gasoline, a part of crude oil, is used in motors to produce motion power. But electricity is still the most convenient form to transport energy for most uses.

4.2
Changing Electrical Energy Into Motion Energy

4.2
Students need to realize that electrical energy is converted into motion energy by electrical motors. An electric motor is constructed nearly the same way as an electrical generator. Instead of using motion energy to turn the magnet and produce electricity, you use electrical energy to cause the magnet to turn which is connected to the motor shaft.

This can be demonstrated by running any electrical motor. As the students observe the motor run, have them explain how energy is changing form.

4.3
Changing Electrical Energy Into Heat And Light

4.3
Students need to realize that electrical energy can be changed into heat energy and light energy. Toasters, irons, and electric ranges are examples of electrical energy being converted into heat energy. Light bulbs are typical examples of electrical energy being converted into light energy.

Both of these conversions involve the same basic process. If you make it hard for electricity to move through a wire, the electricity changes to heat, then if the wire get hot enough it produces light. Students can observe this with either clear light blubs or an old style toaster where you can see the heating element.

4.4
Changing Gasoline (Chemical Energy) Into Motion Energy

4.4
This activity will increase student awareness of how chemical energy can be changed into motion energy. A typical example is illustrated in the operation of the automobile engine. The chemicals in gasoline burn very easily. When the gasoline burns, it heats the surrounding air. As air is heated it expands. Inside the automobile engine, the expanding air causes pressure which in turn pushes a piston down. The downward motion of the piston is converted into circular motion that turns the wheels. By repeating this process over and over within each cylinder, the engine continues to run and provides a continuous power to the wheels. Some students may have a plastic model of an engine that he can bring to school and demonstrate in more detail how gasoline is converted into motion.

The expansion of air as it warms can be illustrated. Blow a balloon partially up and cool it so the air inside is relatively cool. Record its size by seeing how long of a string is required to go around it. Place the balloon in a warm place until the air inside has increased in temperature then measure its circumference again and compare. Of course, inside an engine this change occurs much more rapidly.

onverting Crude Oil
nto Usable Energy Forms

By the end of this activity, students will be able to name three common, usable forms of energy produced from crude oil and be able to briefly describe how these products are extracted from the crude oil.

Man has known about crude oil for many years. Before drilling for oil, started in 1859, there were places where oil seeped out of the ground. Men would collect oil from these seeps and use it for lubricating machines and burning for light. When crude oil is burned it produces a lot of smoke. When crude oil is pumped from the ground, it is not very usable. Today, by refining the crude oil, separating the crude oil into different substances, we are able to use it many different ways.

Crude oil coming from the ground is a mixture of many different substances. In a refinery, the different substances are separated as the crude oil is heated. Heating causes the substances to change into gases and evaporate above the remaining liquid. The evaporated substance is collected and stored for selling. Each kind of substance evaporates at a different temperature, thus allowing them to be separated.

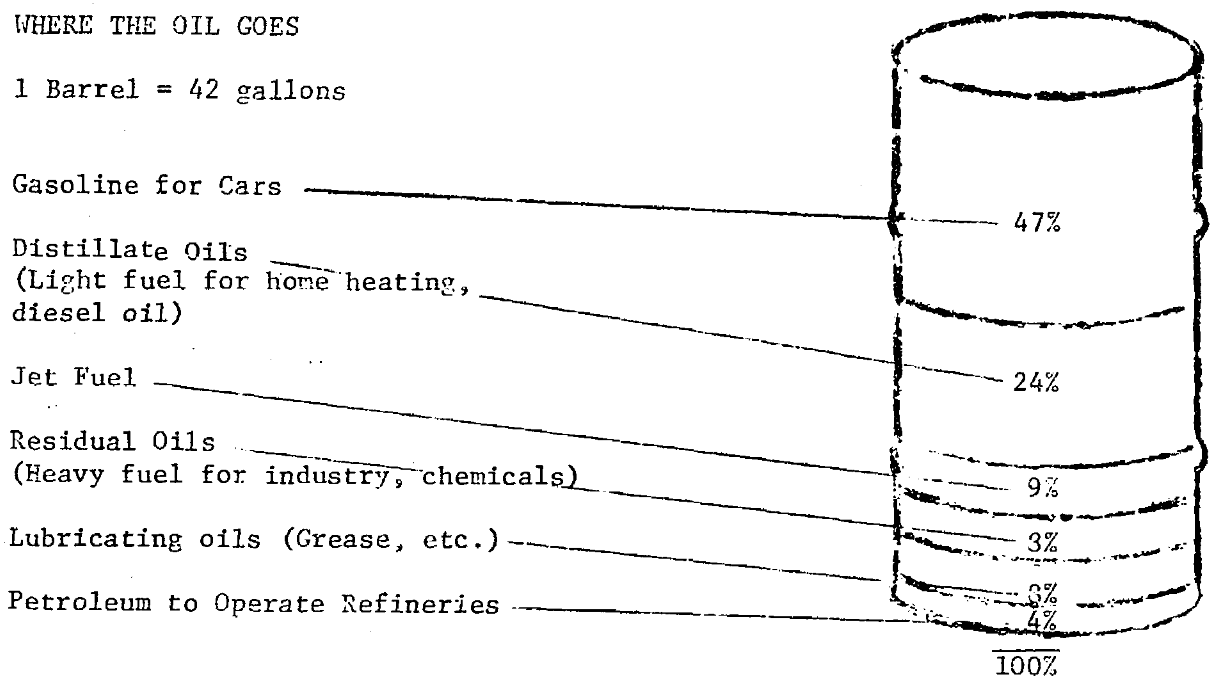
The following diagram illustrates the general percentages and substances that are normally separated from a barrel of oil.

Cars Gulp Most Oil

The chart of figures provided by the Petroleum Industry Research Foundation showed the uses, by percentage, of oil consumed in the United States.

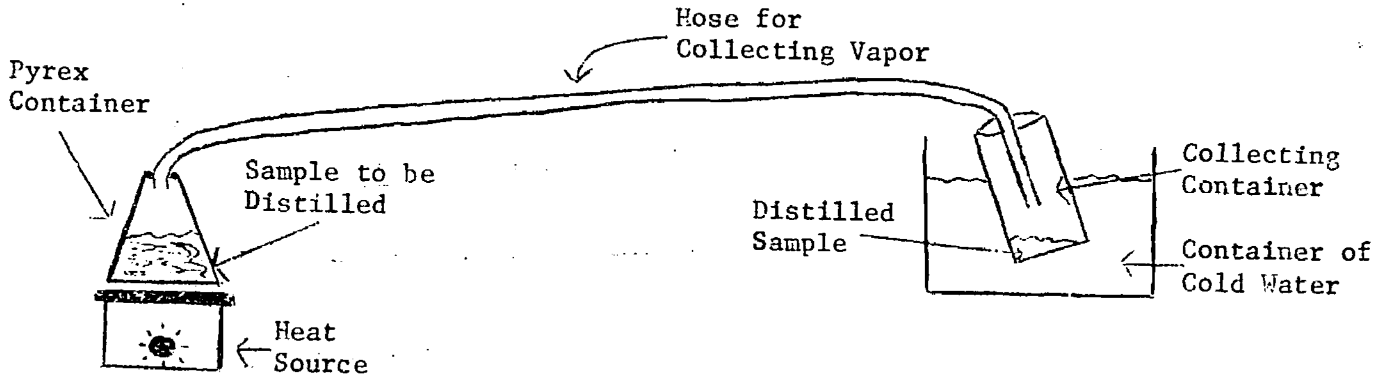
WHERE THE OIL GOES

1 Barrel = 42 gallons



4.5
Converting Crude Oil Into Usable Energy Forms (Continued)

4.5
Samples of crude oil can be distilled in the classroom to demonstrate the refining process, but extreme caution will need to be practiced due to the flamability of some parts of the oil. The concept of refining can also be demonstrated by using colored water. Use the following setup.



As the water is heated it turns into vapor. The vapor is collected and cooled causing it to turn back into a liquid. If the sample was crude oil, one kind of substance would collect at a given temperature. When all of that substance was driven out, the temperature would go up and a different kind of substance would evaporate and could be collected. This would continue until all the substances were separated.

Would you expect substances with high or low boiling temperatures to separate first? Refineries can also change one substance into another. For instance, if they need more home heating oil, they can take gasoline and process it into home heating oil.

The following data presents some of the products separated from crude oil and the approximate temperatures at which the separation occurs.

	Fahrenheit	Centigrade
Propane	-44°	-42°
Butane	32°	0°
Gasoline	259°	126°
Kerosene	392°	200°
Diesel	482°	250°
Lubricant Oil	662°	350°
Wax, Asphalt, and Other Heavy Material	842°	450°

5.0 Introduction

5.0
The life-style, or way a person lives, is directly related to the amount of energy he can control and have available. The life-style of a primitive tribe, or the life-style of Americans 150 years ago, is very closely related to his body energy, energy from burning wood, and the energy of the animals he controls. Today, Americans can control large quantities of energy by flipping switches and turning knobs on machines.

This topic will discuss some ways we can reduce our demand for energy without going back to the life-style of our ancestors. Of course, any reduction in energy will require changes in our life-styles or habits. Sometimes, these changes are said to result from people developing an energy ethic or attitude. An important point to emphasize with students is that if each person saves just a little energy that when multiplied by the number of people in the United States that amounts to a large quantity of energy. For example, if each car driven saved one gallon of gasoline each day, there would be around 150 million gallons of gasoline energy saved each day.

5.1 Why Be Concerned About Saving Energy

5.1
Students should be able to name three factors that have caused the energy crisis after studying this activity. Debating the "realness" of our present energy crisis is nearly useless, except as a study of how our government, economy, industry, and personal lives are interrelated. During this activity, direct instruction toward the factors that affect supply and usage of energy. Most important factors are: (1) demand for more energy for each person each year; (2) increasing population; (3) the supply of our easy-to-get energy is decreasing; (4) the underdeveloped nations are wanting to develop a life-style similar to ours; and (5) our methods of using energy are causing environmental pollution problems. Each of these factors can be illustrated by using graphs found in Appendix B.

The United States Fossil Fuel Usage and Supply graph, (Appendix I) illustrates the relative amount of coal, oil, and natural gas supplies and how much of each we have used. The bell-shaped curve results from the normal usage of any natural resource. At first the demand is low, and the technology for obtaining is rather poorly developed. Usage goes up as demand and methods for obtaining resources improve. The graph starts downward as the supply is depleted and the portion of the supply remaining gets harder to recover. Students may need to discuss the general pattern of this graph a while before they can understand how this relates to all natural resources. One interesting point to bring out is that it costs more to get the hard to recover resources. This is represented by the curve starting downward. This cost is passed on to customers using products made from the resource. Note that with oil we are

5.1
Why Be Concerned About Saving Energy (Continued)

5.1
starting into the downward slope.

Be sure the students interpret from the graphs that we have already used nearly one-half of our oil and natural gas supply. Coal is the only fossil fuel we have a relative long-range supply of.

The Life-Style Compared to Energy Consumed Per Person Chart, Appendis B, illustrates how much more energy a person uses as he advances his life-style. As less-developed countries move from agricultural to industrial or technological life-styles, their demand for energy will greatly increase. As a result, their demand for energy will be even greater than in the United States.

As students view this chart, remind them the chart is based on one person in a given life-style. Note that the 10,000 kilocalories the technology man uses for food includes the energy in the food, the energy for producing the food, and the energy for processing the food until it is on our table. The 3,000 kilocalories for the primitive man's food is mostly the energy contained in the food as he picked or captured it.

The United States Population and Energy Consumption Graph, (Appendix B) illustrates that because of our life-style each individual is using more energy each year. Explain to the students, if each person used the same amount of energy each year, the population and energy graph would run parallel with each other. Instead, the energy graph is increasing faster which shows that each person is using more energy. Use this same graph to emphasize that the population is increasing. So not only is each person using more energy, but there are <u>more</u> people on the earth each day to use the energy.

The Carbon Dioxide Concentration in the Atmosphere Graph, (Appendix B), can be used to illustrate that increased usage causes an increase in pollution problems. This graph is based on data and predictions collected near Manna Loa, Hawaii. When substances like coal, oil, and natural gas are burned, one of the products formed is carbon dioxide. This carbon dioxide goes into the air and accumulates as part of our atmosphere. In a general way, measuring the carbon dioxide concentration in the air is a measure of the overall effect of our energy usage on the environment. The important thing to notice is that as energy consumption increases the concentration of carbon dioxide in the atmosphere is increased. Other pollution problems would follow a similar graph pattern but vary with local conditions. Examples of other problems would be: thermal (heat) pollution, chemical (sulfur, mercury) pollution, and air pollution, etc.

.1 hy Be Concerned About Saving Energy (Continued)

5.1
End this activity with the thought that we will have an energy crisis in the near future--even if the present one is the result of industry's and the government's poor planning.

5.2 Conserve Energy In The Home

5.2
Approximately 20 percent of our nation's energy is consumed in the home. Students should be able to list ten changes they can make in their home life-style that will reduce their energy usage. They should also be able to indicate which of these saves the most energy. From information from news broadcasts and other sources, students can probably already list many of the ways to conserve energy in homes. Make a list on the board. The Energy Saving Guidebook published by the Electrical Industries Association, 6055 East Washington Blvd., #633, Los Angeles, California 90040, contains a list of suggested ways that might be used to supplement the student list.

After the list is completed, use questions such as the following to direct discussions.

(1) Which of these changes will conserve the most energy?
(2) Which ones are you already doing around your home?
(3) Which are you willing to do?
(4) How will these changes affect your life?

5.3 Conserving Transportation Energy

5.3
Americans consume large amounts of energy to transport themselves from one location to another. Students should be able to explain three ways in which they can reduce energy used in people transportation.

Start by having students list ways to travel. The list should include at least the following: walking, bicycles, cars, buses, trains, airplanes, trains, and riding animals.

Use questions similar to these for a discussion:

(1) What type of energy is consumed with each method of transportation?
(2) Which one do you think uses the most energy per person being moved? (Refer to Activity 2.7 for some data on this.)
(3) Which methods are used for short distances? Which for long distances?
(4) Which method could you use more of to reduce the energy you consume?

5.4
Reducing Industrial Energy Usage

5.4
Following this activity, students should be able to describe three ways they can change their buying habits that will reduce industrial energy needs. Although students cannot directly tell industry how to use less energy, they can change their buying habits which could ultimately reduce the industrial need for energy.

The following data can be presented to the students. Allow them an opportunity to react to it in terms of how it relates to their daily habits.

(1) Buy products in reusable containers. For example, each returnable soft-drink container now returns about 15 times for refill before it is damaged and goes out of circulation. This saves the amount of energy needed to make 14 throw away containers.
(2) The energy required to make eight throw-away bottles is 3.11 times greater than the energy required to make one returnable bottle and reuse it eight times.
(3) Eight throw-away cans use 2.7 times as much energy as one returnable bottle reused eight times. Recovering glass after it is mixed with garbage and remelting requires more energy than manufacturing new glass bottles from raw materials. However; glass separated in our homes and recycled uses less energy than manufacturing bottles from raw materials.
(4) A complete return to returnable bottles in the beer and soft-drink industry would reduce their need for "container energy" by 55 percent without raising the purchase price to the consumer.
(5) Stores sometimes charge more for food in returnable containers because they do not want to handle returnable containers.
(6) The table on the following page represents the energy cost for three types of soft-drink container systems. The figures are based on Btu's per gallon of beverage space and returnables making eight round trips.

	Mining and/or Reprocessing	Transport (to Manufacturers)	Manufacturing	Transport (to Bottler)	Bottling	Transport and return (Bottles to Retailer)	Retailing (50 small not included)	Trash Disposal	Trash Sorting	Total Energy Required
Returnable Bottles	990	124	9673	361	6100	1830	0	89	0	19217
Throw-Away Bottles	5195	650	42559	6895	6100	1235	0	468	0	63102
Remelting Throw-Aways (Recycling)	3636	360	42559	1895	6100	1235	0	0	5983	61770

(7) Twice as much energy is required to make a twelve-ounce aluminum can as to make a twelve-ounce steel can.
(8) Pulp from recycled old newspaper uses 60 percent less energy than pulp from trees.
(9) Manufacturing to replace "quick wearing out" items consumes energy.
(10) The aluminum industry consumes about seven percent of the nation's energy.
(11) Only five percent as much energy is required to recycle aluminum as to extract aluminum from bauxite ore.
(12) Recycled materials will cost less as soon as the recycle business expands.
(13) Energy conservation is going to require changes in our habits.

After viewing these facts, students should come up with ideas similar to these as ways they can reduce industrial energy.

(1) Recycle paper.
(2) Use returnable beverage bottles and return them.
(3) Use less aluminum.
(4) Recycle aluminum.
(5) Buy items that have long life spans.

5.5
Allocation Of Natural Resources

5.5
Since our reserves of fossil fuels and other natural resources are becoming smaller and harder to obtain, we must see that each limited resource is used in the most beneficial and effective way. Allocation of natural resources for specific use must be considered. Laws will be needed to accomplish this.

Not all fuel supplies are equally well suited for all types of use. For example; natural gas is a much better home heating fuel than coal. The natural gas is easier to transport to the homes and burns much cleaner than coal.

Power plants and industries also like to burn natural gas because it is clean burning and easy to handle. But, as natural gas supplies get harder to obtain priorities must be established to be sure that each type of fuel is used to its best advantage. Power plants and industries that use large quantities of fuels can more easily construct and operate pollution control devices than can individual home owners.

For these reasons, the Federal Power Commission has established a nine level priority list of natural gas users. The last (number nine) priority is the large industries and power plants. This means they will be the first to lose their natural gas supply and will be required to change to some other fuel. Homes and small businesses received a number one priority. This means all other gas users will loose gas service before homes and small businesses. At present it appears there will be natural gas available for home usage for at least the next 100 years. Much of this natural gas will be produced through coal gasification.

By watching the news, students should be able to find other government priority lists, such as gasoline. Have the students think about all the ways energy is used and try to list them in some order of priority.

5.6
Developing An Energy Ethic

5.6
Changing a person's life-style and habits is a long-range task. The limited examples and illustrations of energy conservation presented in this topic are intended to increase awareness of the need for changes. Through discussion with the students, end this topic with the student's realizing that in order to have energy conservation, individuals, industries, and governments will need to change some of their basic values relating to what is a "good life."

6.0
Introduction

6.0
The activities of this topic will attempt to bring attention to a few of the energy related pollution problems. There is much current information relating to these problems, so students should provide considerable relevant information.

Not only does the direct usage of energy cause pollution problems, such as smog, but our use of energy allows us to create throw-away items causing solid waste problems. Energy enables us to greatly alter the natural landscape by mining, and building roadways, cities, dams, and etc.

6.1
Energy Usage
And Health

6.1
As energy is used some of the end products are chemicals and small particles which cause air pollution. After working with this activity, students will be able to explain one way energy usage affects our health.

Emphysema is a disease of the lungs that causes shortness of breath. The lungs of people with emphysema lose their ability to stretch and to handle large volumes of air. Have the students study the "Comparative Data On Emphysema" in Appendix B. Be sure to go over the information below the graphs before discussing them.

Following the discussion, students should conclude that increased use of energy for industry appears to cause an increase in human disease from the resulting pollution. They should also realize this pollution appears to affect older people more than young people.

Be sure to point out to the students that this is only one small sample of data. It could be that the increase of emphysema resulted from more people smoking or some other affect. Also, recently installed pollution control devices will hopefully reduce the air pollution.

6.2
Sources Of Air
Pollution Relating
To Energy Usage

6.2
By the end of this activity, students should be able to give examples of three kinds of end products resulting from our use of energy that cause air pollution problems. They should also be able to name the three main sources of these pollutants.

Any time energy is changed from one form to another, or used, there are products formed. Many of these end products are present disposal problems. When our life-style was not as advanced and the main source of energy was animal power, the animal waste could be returned to the land as fertilizer.

6.2
Sources Of Air Pollution Relating To Energy Usage (Continued)

6.2
Place the following table on the board for students to view.

NATIONAL SOURCES OF MAJOR AIR POLLUTANTS
(millions of tons per year)

Source	Carbon Monoxide	Sulfur Oxides	Hydro-carbons	Nitrogen Oxides	Partic-ulate Matter	Misc. Other	Total
Transportation	66	1	12	6	1	*	86
Industry	2	9	4	2	6	2	25
Power Plants	1	12	*	3	3	*	20
Space Heating	2	3	1	1	1	*	8
Refuse Disposal	1	*	1	*	1	*	4
Total	72	25	18	12	12	4	143

*less than 1

Students will have heard of most of these terms before, but it is worthwhile to briefly discuss each one.

(1) Carbon monxide - this is a poisonous gas that forms when any substance burns without enough exygen. It is most often associated with car exhaust. This is what kills people who sit in a closed-up car with the engine running.

(2) Sulfur oxide - This is a gaseous compound of sulfur and oxygen. Sulfur oxide combines with water vapor in the air to form sulfuric acid which can kill plants and damage buildings and other materials. When breathed into the lungs, it can damage the lung tissue. Most often, it is formed in places where coal is burned. This causes the greatest problems for power plants trying to control air pollution.

(3) Hydrocarbons - Are a wide variety of chemicals, such as found in unburned gasoline from car exhaust. It is made up mostly of hydrogen and carbon.

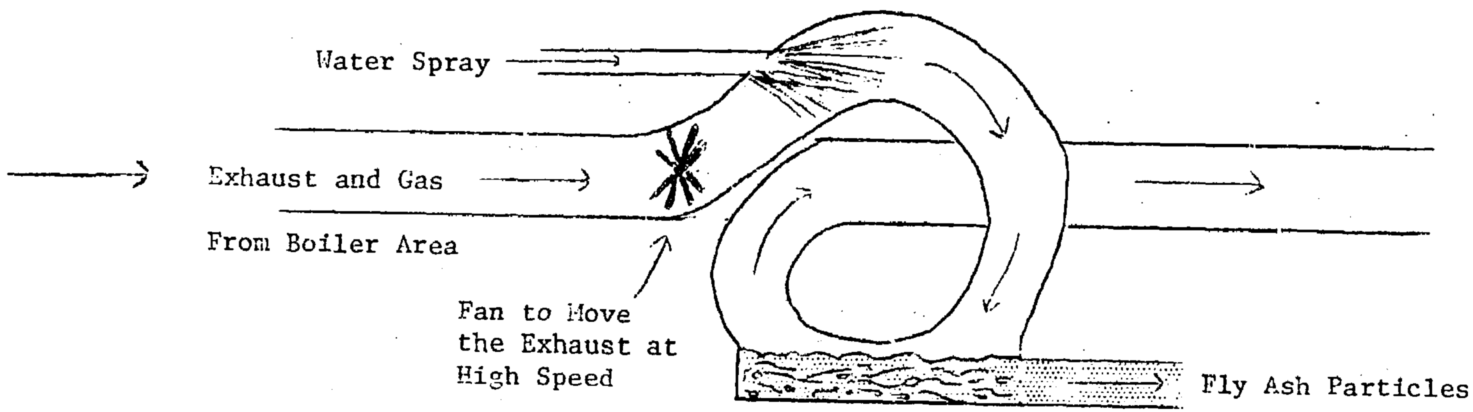
2 Sources Of Air Pollution Relating To Energy Usage (Contunued)	6.2 (4) Nitrogen oxide - This results only when fuels are burned at high temperatures--such as in a car engine. When the nitrogen oxide is exposed to sunlight and other substances it is changed into nitric acid. This nitric acid can be harmful to plants and other materials. (5) Particulate matter - Particulate matter includes any substance that is in the form of small particles. Among the most common causes of particulate matter is the fly ash resulting from burning coal and oil not properly burned which forms black soot or particles. End this discussion with the students realizing transportation, is the biggest source of air pollutants followed by industry and power plants. Carbon monoxide, sulfur oxide, and hydrocarbon are the major forms of air pollution resulting from burning energy producing fuels.
6.3 Problems Associated With Extracting Fossil Fuels From The Earth	6.3 Pollution problems are not only associated with the releasing of energy from the fossil fuels, but also with the removing of them from the earth and transporting them to the place where they will be used. By the end of this activity, students will be aware of at least two ways of obtaining and transportating fossil fuels that can create environmental problems. Use the short story, "Black Lung," Appendix C, as an illustration of the problems associated with coal mining. The story can either be read to the class, presented by a student, or used as a group reading assignment. By using the discussion questions at the end, the students should gain insight into some of the health problems associated with underground mining. Students can research other environmental problems by using the library newspapers and magazines to find out information on the following: (1) oil spills, (2) strip mining, (3) Alaskan pipeline, and (4) salt water from oil wells.
6.4 Control Of Environmental Problems Resulting From Energy Usage.	6.4 The natural system of the earth could handle small quantities of societie's pollution. As the number of people and the amount of waste increased, the natural system was overloaded. Also, our technology created types of chemicals that could not be re-cycled by the natural system. By the end of this acticity, students should be able to list three ways we are attempting to control pollution problems relating to the usage of energy. Start this acticity by having students name any ways and/or techniques we have tried or are using to reduce air, water, or solid waste problems resulting from use of energy.

.4 Control Of Environmental Problems Resulting From Energy Usage (Continued)

6.4 This list might include the following: (1) pollution control devices on cars, (2) special pollution control devices for industries and power plants, (3) new state and federal pollution control laws, (4) trash burning ordinances, (5) trash dumping laws, (6) recycling, and (7) using waste heat from power plants to raise fish.

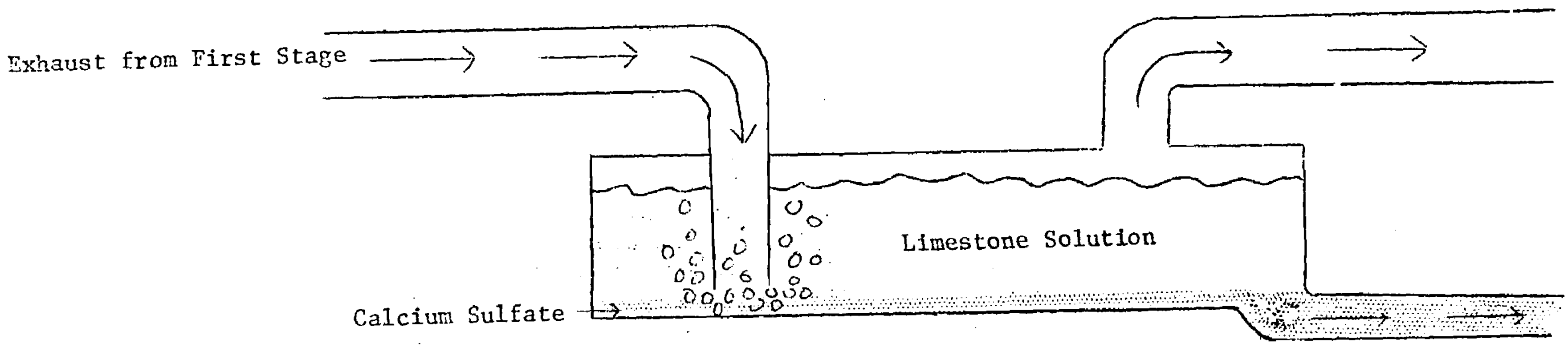
Power plant air scrubber system - Most power plant air pollution problems result from the burning of coal or oil used to make steam. The waste products from the burning contain sulfur, praticulate matter and other substances that can be harmful when they get in the air. Power plant air scrubbers and other pollution control devices are designed to remove most of these harmful substance. See Appendix A for a diagram of the system presently being used at the electrical plant in La Cygne, Kansas.

In the La Cygne power plant the exhaust gas is removed from the boiler area and moved into the first stage of the scrubber. In this first stage, the waste gas is moved at high speeds and sprayed with water. The water combines with the fly ash particles and they settle to the bottom and are collected.

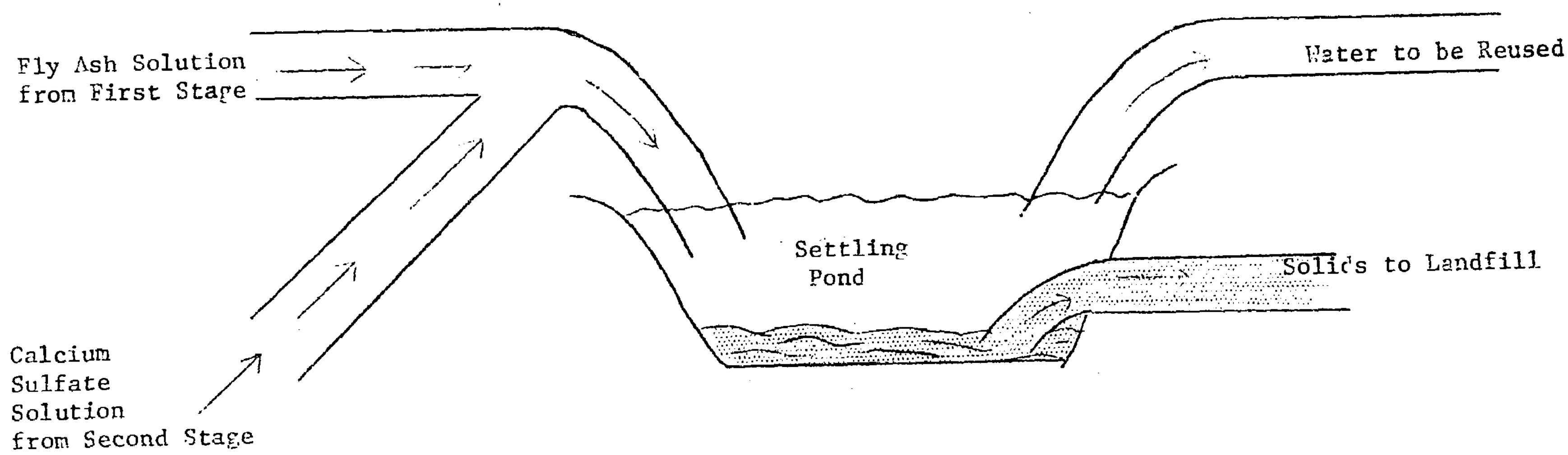


4
Control Of Environmental Problems Resulting From Energy Usage (Continued)

6.4
After going through the first stage which removed the fly ash (large particles) the waste gas is piped into a large tank of limestone water solution. As the gas moves through this solution, the sulfer combines with the calcium of the limestone to form calcium sulfate. The calcium sulfate is then removed. As a result of this stage most of the sulfur has been removed from the waste gas.

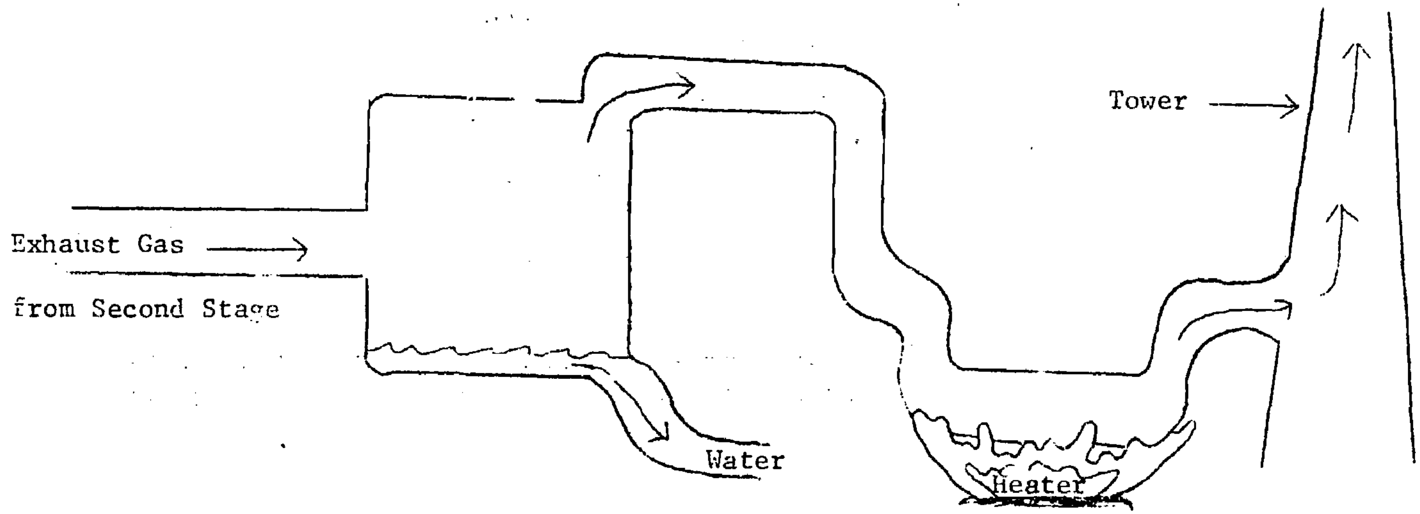


The fly ash and calcium sulfate are removed from the scrubber to a settling pond where they are collected and removed to a land field.



6.4
Control Of Environmental Problems Resulting From Energy Usage (Continued)

6.4
From the second stage, the exhaust gas goes to a third stage area where the excess water is removed and the gas is reheated. From here, the hot waste gas is returned to the atmosphere through a 700-foot high tower.



By the time waste gas has passed through the scrubber, 99 percent of the particle matter (dust and ashes) and 80 percent of the sulfur has been removed from the waste gas before it enters the atmosphere. Systems like this one are expensive, difficult to maintain, and consume a lot of energy. The scrubber at La Cygne uses enough electricity to supply a city the size of Junction City. It is important that the students realize that energy used for pollution control is not wasted but rather is used to keep our environment livable.

This can be followed up by students finding out how other types of pollution control devices operate.

7.0 Introduction	7.0 The major purpose of the field trip will be to observe how different life styles require different amounts of energy. The field trip will utilize the Indian Gallery, Agricultural Hall, and Period rooms in the Kansas State Historical Society building. In addition, the trip to and from the trip site will be used to point out ways in which energy is made available and utilized in the Topeka area.
7.1 Trip Preparation	7.1 Before the field trip, the class should study activities in the first six topics of this unit. The specific activities used to accomplish the objectives may vary in each classroom. The selected activities should prepare the students to meet the unit objectives and they should be appropriate for the students. Teacher needs to fill out a field trip request form (sample included in Appendix E) and submit it to the principal. Parents need to be notified about the trip. Parent signatures may be required by the principal. (Sample parent letter in Appendix E.) Arrange for field trip leaders and transporation well in advance. Each student will need: (1) one copy of the field trip data sheet, Appendix E, (2) pencil, and (3) a clipboard or notebook.
7.2 Field Trip Leader Directions	7.2 Leaders should be aware of the unit goals and purposes of the field trip. Appendix E contains on-site leader directions. During the field trip, each leader should have no more than 12 to 15 students. This will permit leader-student interaction and closer observation.
7.3 Field Trip Follow Up	7.3 After the students return to the classroom, they should be allowed to discuss and exchange trip observations. Relate the field trip observations to the various activities that have been previously discussed. The teacher field trip discussion guide (Appendix E) will assist in directing the follow-up discussion. You may wish to do some of the unit activities previously omitted.

APPENDIX A

Teacher Resource Materials

MATH ACTIVITIES

1. Food Energy Problems

   A. In 1970 the average American consumed 1,500 pounds of food. How many pounds of food did each American eat each day?____________________

   B. Daily this food provided the average person with 3,300 calories. How many calories are in each pound of food? ____________________

   C. How many calories of energy are contained in the years supply (1,500 pounds) of food for one person? ____________________

   D. To produce, process, transport, store, and prepare this one person's food requires 2,000 trillion calories of energy in the United States. Is this more energy than our body gets from the food? ____________________

   E. How many times larger is this energy input than the energy we get from the food? ____________________

   F. Where does this supply of "excess" energy come from? ____________________

   G. How do you think this energy usage compare with the energy used to provide food for people of other countries? ____________________

2. Energy and Air Pollution

   A. During an average winter day it is estimated that 335 tons of particulate matter goes into the air over New York City from cars and industry. Most of this eventally settles to the ground. How many tons of air polluting settles to the ground during the winter months? At this rate how many tons of air polluting particles goes into the air over New York City in a year?

      ____

   B. There are 2,000 pounds in a ton. How many pounds of air polluting "stuff" is this? ____________________

   C. There are around 7,800,000 people living in the New York City area. How many pounds of air pollution is this for each person? ____________________

   D. In Kansas City during the winter as much as 67 tons of dustlike particles fall from the air on each square mile of surface during a month's time. How many ton will fall on each square mile during a year at this same rate? ____________________

   E. There are around 320 square miles of area covered by Kansas City. What is the total tons of "stuff" falling on Kansas City? ____________________

   F. Around 508,000 people live in the Kansas City area. How many pounds of particulate air pollution is this per person? ____________________

   G. Two hundred million tons of gases and particles goes into the air over the United States each year from our homes, industry, cars, and other sources. The United States population is around 200,000,000. What is the total amount of "stuff" going into the air for each person? ____________________

3. Heat Energy

A. To heat one gallon of water one degree Fahrenheit in an electric water heater requires 0.0024 kilowatt-hours (kwh) of energy. How many kwh of energy would it require to heat 50 gallons of water one degree Fahrenheit? ___________

B. Many home water heaters hold 50 gallons of water. The water entering the water heater may be 40°F. The water heater raises the water temperature to 150°F. How many degrees is the water to be heated? ________________ How many kwh of energy does it take to heat the 50 gallons of water from 40°F to 150°F? ____________________

C. Electrical energy cost around three cents for each kwh. How much does it cost to heat the 50 gallons of water from 40°F to 150°F? _________________

D. If a hot water faucet leaks one drop a second it will waste 70 gallons in a year. Assume this water was heated from 40°F to 150°F, how much energy was wasted in a year? How much did this cost at the rate of three cents per kwh? _________________________

E. A gas operated 40 gallon water heater is rated at 42,000 Btu's per hour. Each gallon of water requires 8.33 Btu's to change it's temperature one degree Fahrenheit. How many Btu's are required to heat 40 gallons of water 1°F?_______________________ How many Btu's are required to heat the 40 gallons from 40°F to 150°F? ____________________ Can 40 gallons of water be heated from 40°F to 150°F in one hour? _____________________

4. Energy for Transportation

A. The average American car uses 772 gallons of gasoline each year, and gets 13.3 miles per gallon of gassoline. How many miles does the average car travel in a year? ___________________

B. Each gallon of gasoline contains about 125,000 Btu's of energy. How many Btu's does the 772 gallons of gasoline the average car burns each year contain? __________________________

C. There are nearly 98,000,000 privately own cars in the United States. How many total gallons of gasoline are used each year if each car uses 772 gallons? __________________________

D. A Ford Pinto weights about 2,500 pounds and gets about 21 miles per gallon of gasoline. A full size Ford weights about 5,000 pounds and gets about 10 miles per gallon of gasoline. If a family travels 12,000 miles during a year, how many gallons of gasoline would they need if they owned a Ford Pinto? _______________________ How many gallons will they save by driving the Pinto? ________________ If gasoline costs 40 cents per gallon, how many dollars would they save? ____________________

E. How many gallons of gasoline will the full size Ford in the above problem need to drive for one hour at a speed of 70 miles per hour (assume 10 miles per gallon)? _____________ If the energy in each gallon is equal to 38.3 kwh, how many kwh is the gasoline used in one hour equal to? ____________ (This is nearly the same amount of energy the average family uses in the form of electricity during a whole week.)

5. Power - Energy Problems

This information may be helpful when working the power-energy problems.

Power is the force that is required to do the work. It is often measured in watts (for electricity) or horse power (for motors and engines).

Energy is the "stuff" that provides the power or force, hence, the more power needed the more energy used. Energy is measured in large Calories (for food), small calories (heat), British Thermal Units (Btu), (for large heat units), and kilowatt-hours (kwh), for electricity.

Power conversion equivalents for electrical operated equipment: Watts = Voltage times amperes (the voltage and amperes are printed on many appliances).

1 kilowatt = 1,000 watts or 10^3 watts
1 megawatt = 1,000,000 watts or 10^6 watts
1 horsepower (hp) = 746 watts

Energy units and equivalents

1 kilowatt-hour (kwh) = 1,000 watts power for one hour
1 large Calorie (food) = .0012 kwh or 1.2 watt-hours
1 British Thermal Unit (Btu) = 0.00029 kwh
1 hour of human labor = .06 kwh
1 kilowatt-hour = 34.3 Btu's

A. If a 60 watt bulb is used for five hours, how many watt-hours of energy are consumed? ____________ How many kilowatt-hours is this equal to? ____________

B. If an iron operates on 110 volt of electricity and requires 10 amperes to operate it, what is its wattage requirements? ____________
If the iron is used eight hours per week, how much energy (kilowatts-hours) does it use in a year? ____________

C. An electric clothes dryer uses about 5,000 watts of power. How many kilowatt-hours of energy is required to dry four loads during the week if it takes one-half hour to dry each load? ____________ What is the weekly cost to operate the dryer if it cost three cents for each kwh of energy? ____________

D. Instant on model televisions are constantly using electricity to keep the set warm. Many models use about 25 watts power to do this. How many watts hours is this in a year? ____________ How many kwh? ____________ What does this cost at the rate of three cents for each kwh? ____________

E. A standard refrigerator uses about 580 kwh of electricity in a year. A frost-free refrigerator of the same size will use about 750 kwh of electricity in a year. How much more energy does the frost-free refrigerator use? ____________ At a cost of three cents per kwh, what does each type refrigerator cost to operate for a year? ____________ How much more does the frost-free convenience cost? ____________

F. Efficiency of clothes dryers and air conditioners vary greatly. Efficiency ranges from 4.7 to 12.2. The higher the number the more service you get from the energy used. Find the efficiency by dividing the Btu per hour rating by the number of watts input. The Btu and watt numbers are printed on the machines.

ENERGY RELATED STUDENT ACTIVITIES

1. Contact a local home insulating business, power company, or gas service company for information about: (1) proper home insulating to conserve energy, (2) types of insulation, (3) how much is needed under floors, in walls, over ceilings, and how to best insulate windows, and (4) what is R value?

2. Have parents and/or neighbors carefully record their car mileage and gasoline usage for two weeks. From this information calculate the miles per gallon for each car. Compare the miles per gallon of each car based on weight, size, age, types of driving, and date of last tune-up.

3. Ask parents for their old electricity and gas receipts for the last two to five years. Construct graphs showing the monthly cost of each of these sources of energy for a family.

4. Keep a record for two weeks showing every time your family cars are driven, what they were used for, how far the cars traveled each trip, and who was driving.

5. Select a rather busy street near your home and count the number of cars, trucks, buses, other vehicles, and the number of people in each vehicles.

6. Contact your local grocery store manager. Ask him to explain: (1) the problems he has in handling returnable type soft drink containers, (2) ways he thinks consumers could be made more aware of the energy saved by using return containers and recycled material.

7. Keep a careful record of all your activities for one week. Beside the activity indicate the types of energy you were using.

8. Get up-to-date information about energy by contacting your state, local, and federal government officals. Write for specific information important to you and ask to have your name placed on their mailing list. Your school librarian can provide you with current names and addresses of elected officals.

9. Start an energy saver for the week poster program. Each week make posters showing how energy can be saved. Select a different area of energy usage for each week. Areas might be: home, travel, school, business, industry, and recreation. Try to have the posters show how students can influence the energy usage in each area. Students may need to do special research for the poster information.

10. Do research on how to construct simple model of an electrical generator. Construct the model generator and explain its operation to the class.

11. Make large posters illustrating different sources of energy and how they can be captured for our use. Some examples: (1) hydroelectric, (2) tidal, (3) solar, (4) winds, (5) geothermal, and (6) nuclear.

12. Use the library and other sources to find out what kind of pollutants are formed when gasoline is used in cars. How do these pollutants affect plants, animals, man, and buildings.

13. Contact the local heart and lung association offices for information about how pollution resulting from our using energy affects health.

14. Use the library and local car dealers to find out how car air pollution control devices operate.

15. At the present time, the demand for electricity by citizens of the United States doubles every 10 years. Make a graph illustrating our electrical usage if we continue at this rate.

16. Construct a scrapbook of articles and newspaper clippings about energy. Compare the facts from different sources that are dealing with the same topic.

FACTS AND COMMENTS FOR DISCUSSION

1. A 100 watt incandescent light bulb left buring for a month will use about two dollars worth of electricity.

2. Flourescent lighting is four times as efficient as incandescent lighting and each lamp lasts from seven to ten times as long.

3. Frost-free refrigerators require about 50 percent more energy than standard models.

4. The United States contains only 6 percent of the world population, but consumes one-third of the world's energy.

5. "There are two things wrong with coal today. We cannot mine it and we cannot burn it." This was on a sticker on a car bumper.

6. Forty-six percent of our energy is lost or wasted before it gets to the consumer.

7. For every 10 gallons of gasoline that gets into a car the equivalent of two gallons are required to make and transport the 10 gallons to the car.

8. To manufacture and deliver one automoblie requires 150 million Btu's of energy. This is equal to the energy in 1,200 gallons of gasoline or enough to drive the car 16,000 miles.

9. A lot of energy is wasted by industry and power plants as heat which causes heat pollution problems.

10. Sea life in the area of a nuclear fuel reprocessing plant in West Valley, N. Y. shows high levels of radioactive material in their bodies.

11. One-fourth of all electricity produced goes into lighting.

12. The 1965 recommended lighting level is 2,000 times brighter than the 1910 level.

13. Some scientist believe that reading in lower levels of lighting strengthens the eyes.

14. Some modern buildings have so many lights that they produce enough heat to keep the building warm without other heating until the outside temperature gets down to 10^{o}F.

15. About 50 percent of our freight is moved by trains and they use only about 10 percent of the transportation energy supply.

16. About 50 percent of our freight is moved by trucks and airplanes and they use nearly 90 percent of the transportation energy supply.

17. The more energy an individual can control the more he can alter or change the environment.

DIRECTIONS FOR COMPLETING THE "HOME USE OF ENERGY CHECK LIST"

It is suggested that you not require students to place their names on the check list. This may prevent some students hesitating to fill it out.

Column I: In the first column, the students are to record the number of the given item present in their home. If they don't have the item in their home, place zero in the space.

Column II: In the second column, they indicate how important they feel the item is to them. They can use a one to four scale, one being very important or they can use: 1 (very important), 2 (important), 3 (like it, but could do without), and 4 (not important).

Column III: The third column contains a list of items found in many homes. After the students have checked on the listed items, spaces are provided for them to add other items found in their homes.

Column IV: In column four, the students record the energy the item requires. Many items contain plates listing wattage or Btu's. The watts or Btu's will give some relative amounts of energy required. If the students cannot find the watts or Btu's for an item, place a question mark in the space. This column will help students determine which items are the biggest energy users.

Column V: In column five, the students indicate the form of energy going into the item to power it. It could be (E) electricity, (NG)natural gas, (C) coal, (M) man's energy, (B) battery, (W) wood, or some others. Sometimes, there will be two different types of an item. Radios could be batteries or electrical. In this case, students should indicate both.

Column VI: In column six, the students indicate the type of energy produced or given out by the item. It could be (H) heat, (L) light, (MO) motion, or some other.

Column VII: In column seven, students indicate how the item helps them. For example: keeps me warm, provides light, makes the work easier, saves time, etc.

Column VIII: In column eight, students estimate the number of hours the item is in operation in an average week.

HOME USE AND ENERGY CHECK LIST*

Number Present In Your Home	Rank According To Importance	Name of Item Using Energy	Amount of Energy Required	Type of Energy Going into the Item	Type of Energy Being Used in the End	Number of Hours Used per Week	How does it help you?
		Electric Radio					
		Portable Radio					
		Electric Can Opener					
		Blender					
		Range (stove)					
		Refrigerator					
		Dishwasher					
		Mixer					
		Hand-operated Can Opener					
		Popcorn Popper					
		Toaster					
		Electric Skillet					
		Food Grinder					
		Waffel Iron					
		Humidifier					
		Telephone					
		Lamp					
		Television					
		Toothbrush					
		Pencil Sharpener					
		Hair Dryer					

*See direction sheet for more extensive directions on how to complete this check list.

Home Use and Energy Check List (Continued)

		Doorbell					
		Vacuum Cleaner					
		Furnace					
		Water Heater					
		Hand Saw					
		Saber Saw					
		Drill					
		Sander					
		Grill					
		Porch Light					
		Clock					
		Sewing Machine					
		Record Player					
		Shoe Polisher					
		Movie Camera					
		Iron					
		Candles					
		Broom					
		Washer					
		Dryer					
		Ceiling Light					
		Fan					
		Deepfreeze					
		Mop					
		Vaporizer					
		Electric Razor					
		Fireplace					
		Toothbrush					

Home Use and Energy Check List (Continued)

		Toys					
		Flashlight					
		Radio					
		Car					
		Grinder					
		Bell					
		Saw					
		Knife					
		Electric Blanket					
		Hot Plate					
		Garbage Disposal					
		Bun Warmer					
		Adding Machine					

DATA ILLUSTRATING UNITED STATES ENERGY USAGE*
(Trillions of British Thermal Units)

Year	Coal	Oil and Natural Gas	Water Power	Nuclear Power	Total
1900	6,841	481	250	-	7,572
1902	7,763	663	289	-	8,715
1904	8,952	864	354	-	10,170
1906	10,541	966	414	-	11,921
1908	10,515	1,247	476	-	12,238
1910	12,714	1,547	539	-	14,800
1912	13,440	1,653	615	-	15,708
1914	12,901	1,957	676	-	15,534
1916	14,737	2,315	729	-	17,781
1918	16,973	2,713	750	-	20,436
1920	15,504	3,503	775	-	19,782
1922	12,628	3,912	675	-	17,215
1924	14,731	5,037	685	-	20,453
1926	15,915	5,815	765	-	22,495
1928	14,940	6,551	890	-	22,381
1930	13,639	7,864	785	-	22,288
1932	9,324	6,342	726	-	16,392
1934	10,418	6,798	721	-	17,937
1936	12,048	8,529	841	-	21,418
1938	9,959	9,022	899	-	19,880
1940	12,535	10,456	917	-	23,908
1942	15,584	11,136	1,177	-	27,897
1944	16,956	13,478	1,387	-	31,821
1946	14,479	14,569	1,446	-	30,494
1948	14,897	17,590	1,507	-	33,994
1950	12,913	19,639	1,601	-	34,153
1952	11,868	23,094	1,614	-	36,576
1954	10,195	24,686	1,479	-	36,360
1956	11,948	28,461	1,598	-	42,007
1958	10,090	29,663	1,740	-	41,493
1960	10,414	32,771	1,775	6	44,966
1962	10,523	35,294	1,780	23	47,620
1964	11,660	38,295	1,873	34	51,862
1966	13,030	41,819	2,062	57	56,968

*Sources: U. S. Bureau of Mines

ENERGY USERS

Scrambler No. 1

S	A	W	T	E	L	E	V	I	S	I	O	N
D	F		I			G	R	I	N	D	E	R
I	U	D	R	Y	E	R	R	A	N	G	E	
S	R	M	O	P		I	R	A	Z	O	R	B
H	N		N	O	B	L	M		D	F		L
W	A	S	H	E	R	L	I		C	I	A	E
A	C	A	R	A	O	B	X	R	A	R	O	N
S	E	L	T	T	O		E		N	E		D
H	A	A	O		M	T	R	L	D	P	L	E
E	T	M	Y	C	S	D	R	I	L	L	L	R
R	F	P	S	A	K	N	I	F	E	A	A	U
R	A	Z	O	R	U	N		B	S	C	M	N
	N	T	E	L	E	P	H	O	N	E	P	P

doorbell
dryer
mop
broom
washer
iron
toaster
furnace
telephone
drill
candles

fireplace
dishwasher
radio
fan (2)
mixer
blender
lamp (3)
grill
clock
range

toys
razor (2)
television
grinder
bell
car (2)
saw
knife
run (2)
ear (2)

ENERGY USERS
Scrambler No. 2

	S	H	A	V	E	R	V	A	C	U	U	M
	S		T	S	K	I	L	L	E	T	C	E
F	R	E	E	Z	E	R	A	D	I	O	A	W
H	U	B	L	A	N	K	E	T	H	O	M	E
F	U	N	E	F	R	O	S	T	F	R	E	E
	S	M	V		C	O	O	K	F	I	R	E
C	T	B	I	K	E	L	A	M	P	E	A	
O	O	I	S	D	L	H	E	A	T	I	N	G
O	V	K	I	R	I	L	R	A	N	G	E	R
L	E	E	O	A	F	F	E	A	N		U	I
I	R	O	N	F	E	H	I	A	N	I	S	L
N	H	E	A	T	E	R	C	E	K	C	N	L
G	T	O	Y	S	A	N	D	E	R	S	H	G

self-cleaning
frost-free
television
humidifier
drafts
heater
sander
camera
range
heating
blanket

bike (2)
oven
fire
cooling
freezer
leaks
skillet
heater
iron
can
grill

radio
lamp
home
cook
ranch
life
toys
fun (2)
me
we
us

ENERGY USERS
Scrambler No. 3

M	O	T	O	R	C	Y	C	L	E	S		B
O	A	R	E	C	R	E	A	T	I	O	N	U
T	L	N	T	F	A	C	T	O	R	I	E	S
O		I	U	R	I	N	D	U	S	T	R	Y
R			F	F	U	J		A	I		P	
B	A	R	G	E	A	C	E	U	G		E	
O	S	H	I	P	S	C	K	T	N	W	O	P
A	H	P	L	A	N	T	T	O	A	A	P	U
T	F	O	O	D	W	A	R	U	L	L	L	M
F	A	R	M	I	N	G	A		R	K	E	P
P	R	O	C	E	S	S	I	N	G	I		I
P	L	A	N	E	S	E	N	D		N	N	N
D	R	I	L	L	I	N	G	K	I	G		G

motorcycles
motorboat
recreation
bus
man
manufacturing
factories
industry
walking

plant
food
war
people
pumping
farming
processing
planes
send

drilling
auto
ships
barge
jet
signal
homes
train
truck

ENERGY SOURCES
Scrambler No. 4

G	A	S	I	F	I	C	A	T	I	O	N	N
R	E	L	E	C	T	R	I	C	I	T	Y	U
E	S	O	L	A	R	C	E	L	L	I		C
E	M	E	T	H	A	N	E	S		D	B	L
N	P	A		H	F	O	O	D	U	E	R	E
P	R	E	N	K	E	R	O	S	E	N	E	A
L	O	A	H	Y	D	R	O	P	O	W	E	R
A	P	R	I	V	E	R	M	W	O	O	D	O
N	A	T	U	R	A	L	G	A	S		E	C
T	N	H	U	O	I	L	S	O	L	A	R	E
S	E	N		D	O	M	E	S	T	I	C	A
G	A	S	O	L	I	N	E	C	O	A	L	N
M	A	N	P	E	T	R	O	L	E	U	M	S

gasification
electricity
nuclear
solar
solar cell
oceans
domestic
petroleum
coal

gasoline
man
natural gas
river
wood
hydropower
kerosene
food
methane

propane
breeder
green plants
manure
oil
geothermal
sun
tide
earth

ENERGY RELATED TERMS
Scrambler No. 5

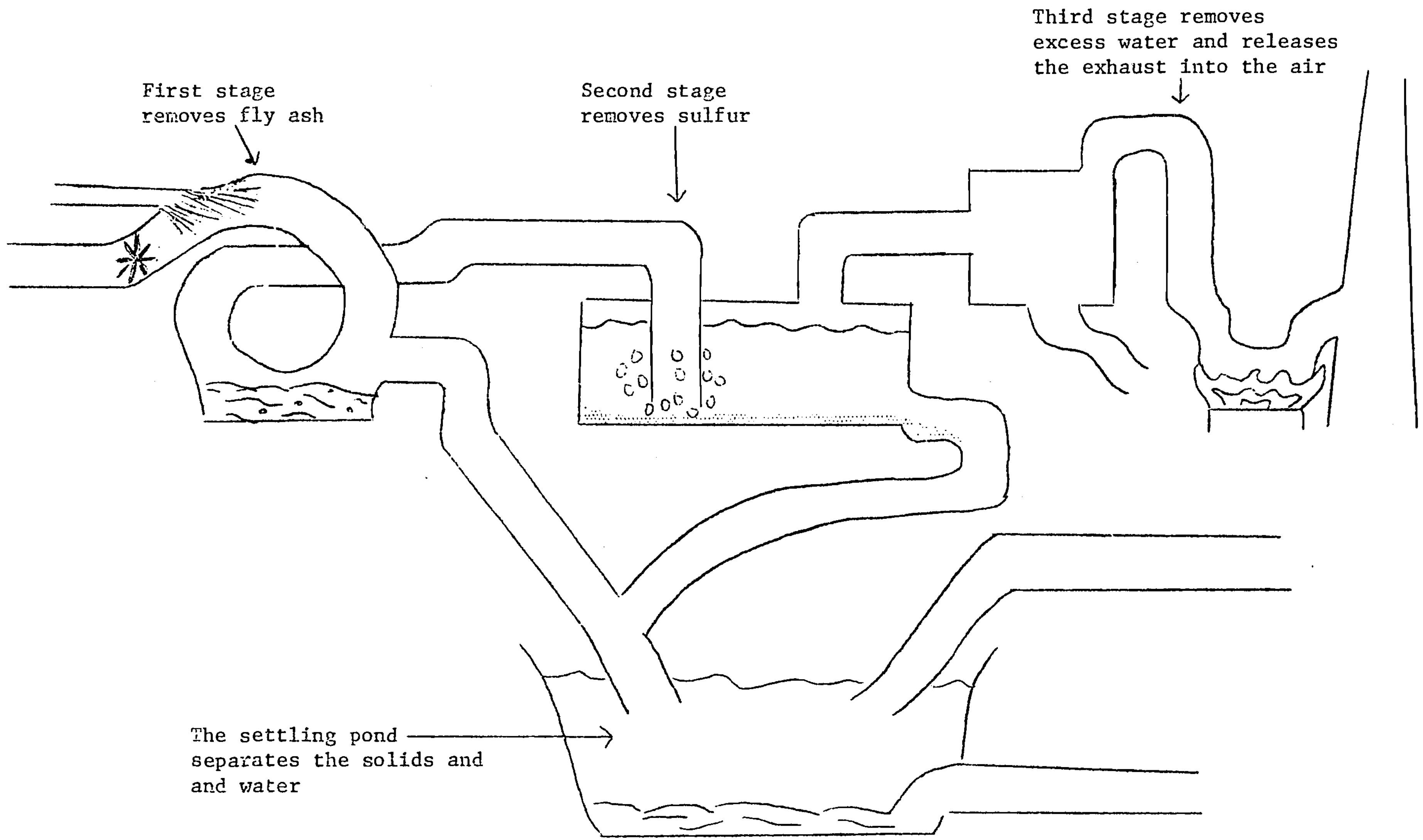
C	A	L	O	R	I	E	S		F	S	E	P
P	O	L	L	U	T	I	O	N	H	U	L	O
G	E	N	E	R	A	T	O	R	E	N	E	O
	F	O	S	S	I	L		B	A		C	L
L	F	T	H	E	R	M	O	S	T	A	T	B
T	I	E	N	E	R	G	Y	Y		U	R	R
U	C	G	A	S	C	V	G	G	A	S	I	O
R	I	I	H	N	C	O	A	L	T	L	C	W
B	E	S	U	T	L	I	S	T	O	A	I	N
I	N	S	C	O	A	L	A	T	I	W	T	O
N	C	U	C	P	O	W	E	R	L	O	Y	U
E	Y	E	N	V	I	R	O	N	M	E	N	T
K	I	L	O	W	A	T	T	S	P	E	E	D

conservation
thermostat
environment
brownout
electricity
calories
ecology
energy
generator
efficiency

pollution
fossil
Btu
watts
cost
light
coal (2)
heat
kilowatts

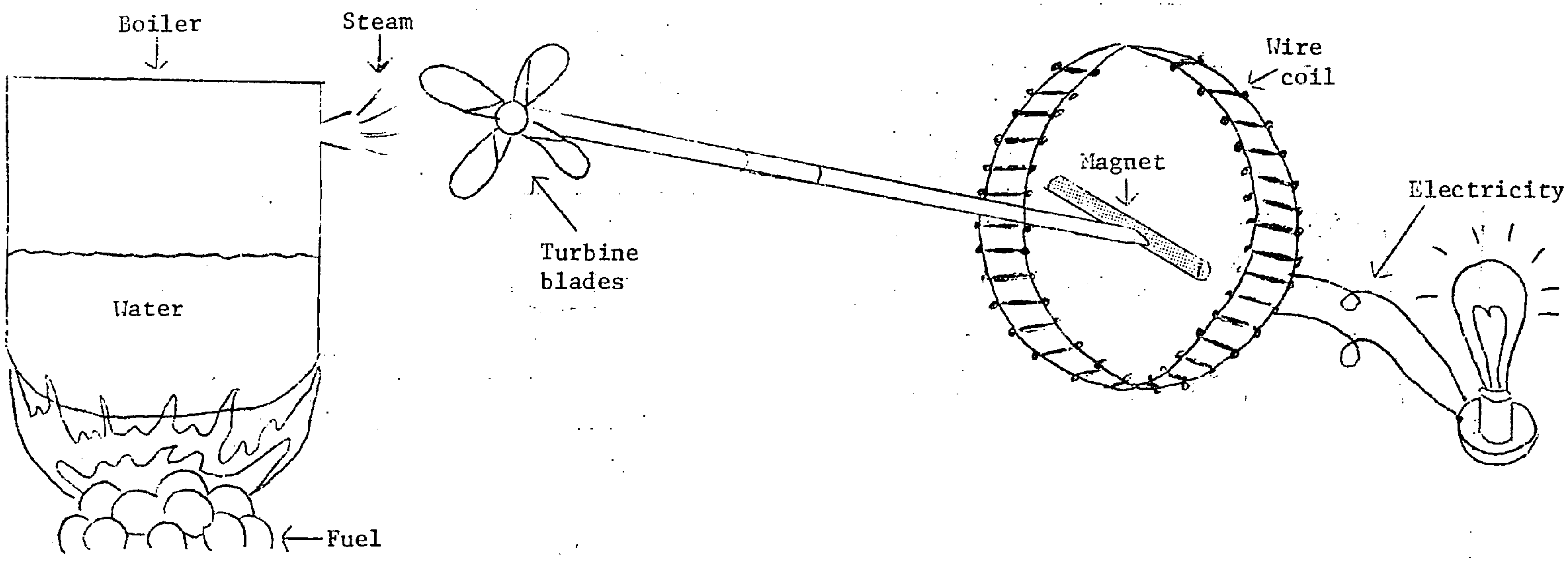
speed
turbine
fuel
gas (2)
oil (2)
sun (2)
power
pool
issue
law

POWER PLANT SCRUBBER DIAGRAM*

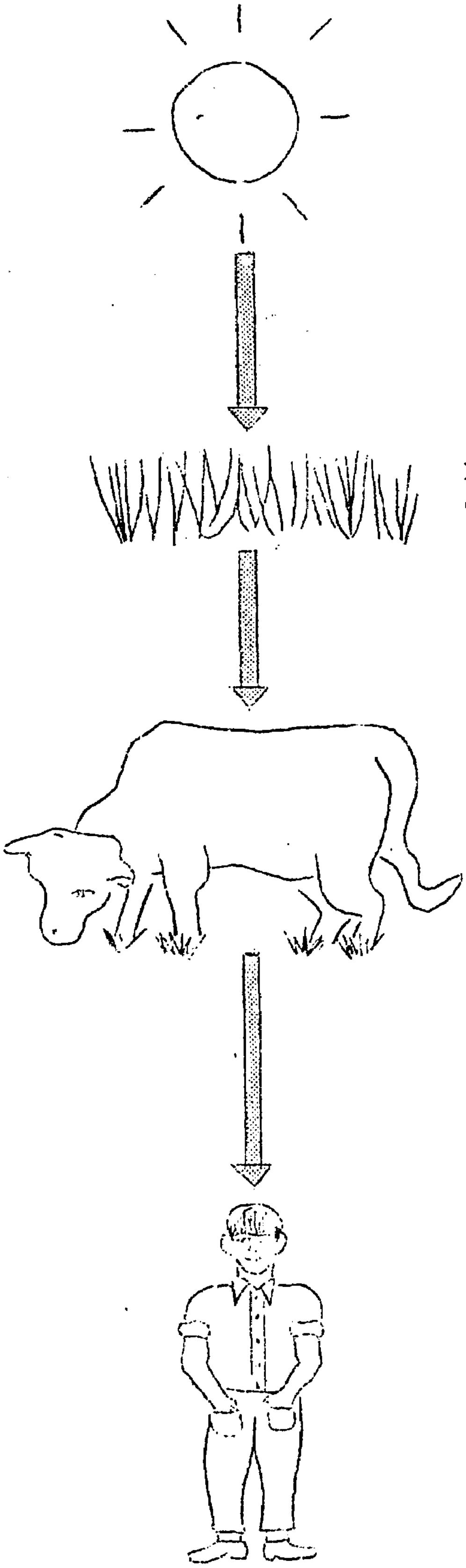


*See Activity 6.4 for details about how the scrubber operates.

SIMPLE ELECTRIC GENERATOR DIAGRAM



ENERGY PATH NO. 1



Sun

Grass

Energy from the sun is captured by the green plants

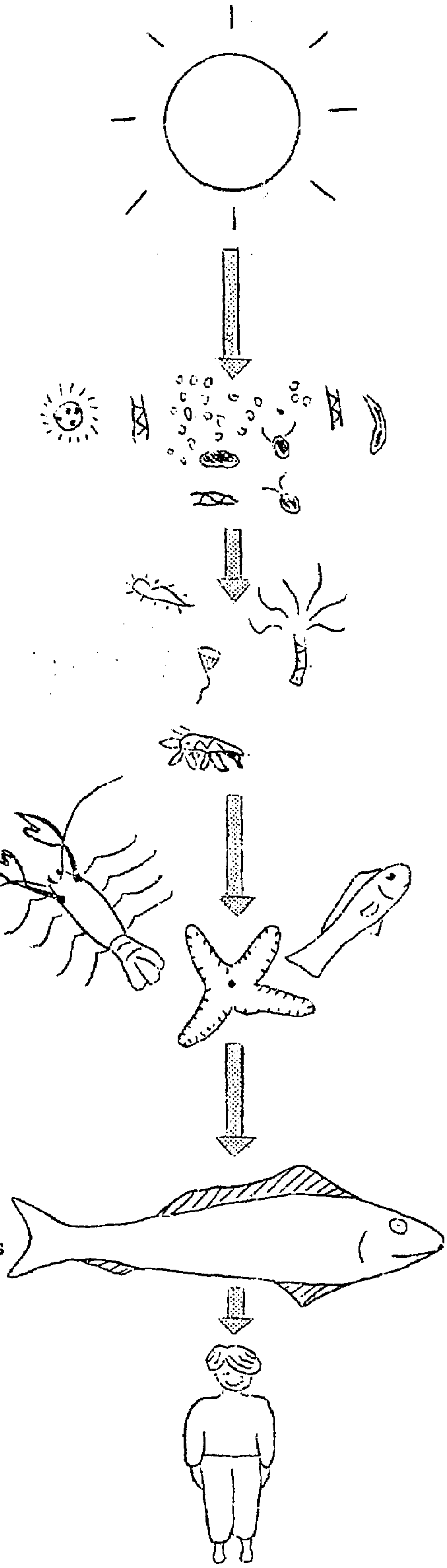
Cow

Energy from the sun, moves from the green plant to the first consumer

Man

Energy from the sun, moves from first consumer to the second consumer

ENERGY PATH NO. 2



Sun

Algae in the seas

The sun's light contains energy that is trapped by the green plants (algae).

Microscopic sea animals

The microscopic animals get their energy by eating the green plants that contain energy from the sun.

Small fish and other small sea animals

Larger animals obtain their energy by eating smaller animals that contain energy from the sun that was first captured by green plants.

Large sea fish such as tuna

The largest animals obtain their energy by eating smaller animals that contain energy from the sun that was first captured by green plants.

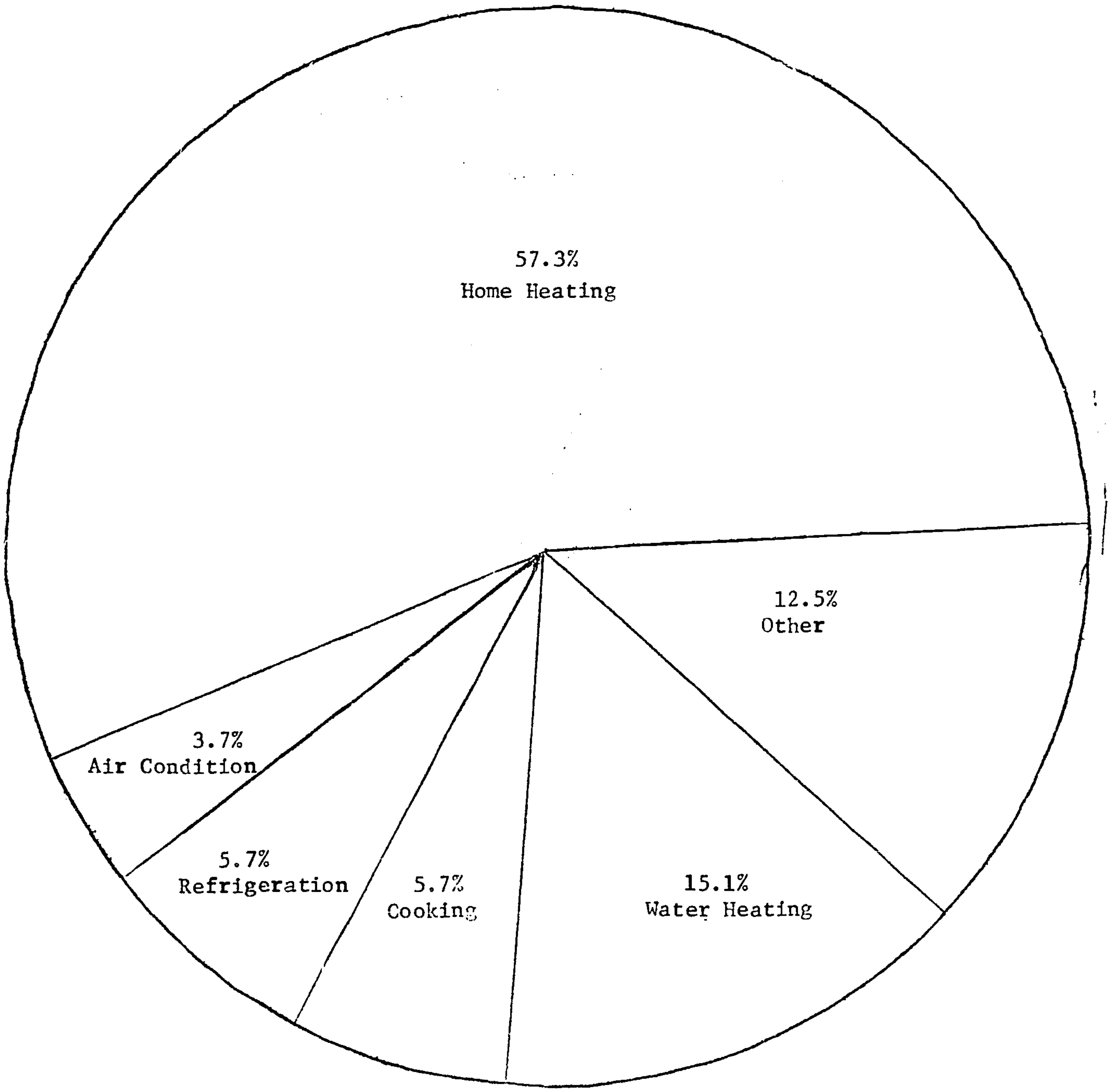
Man

Man obtains his energy from the food he eats which contains energy from the sun that was first captured by green plants.

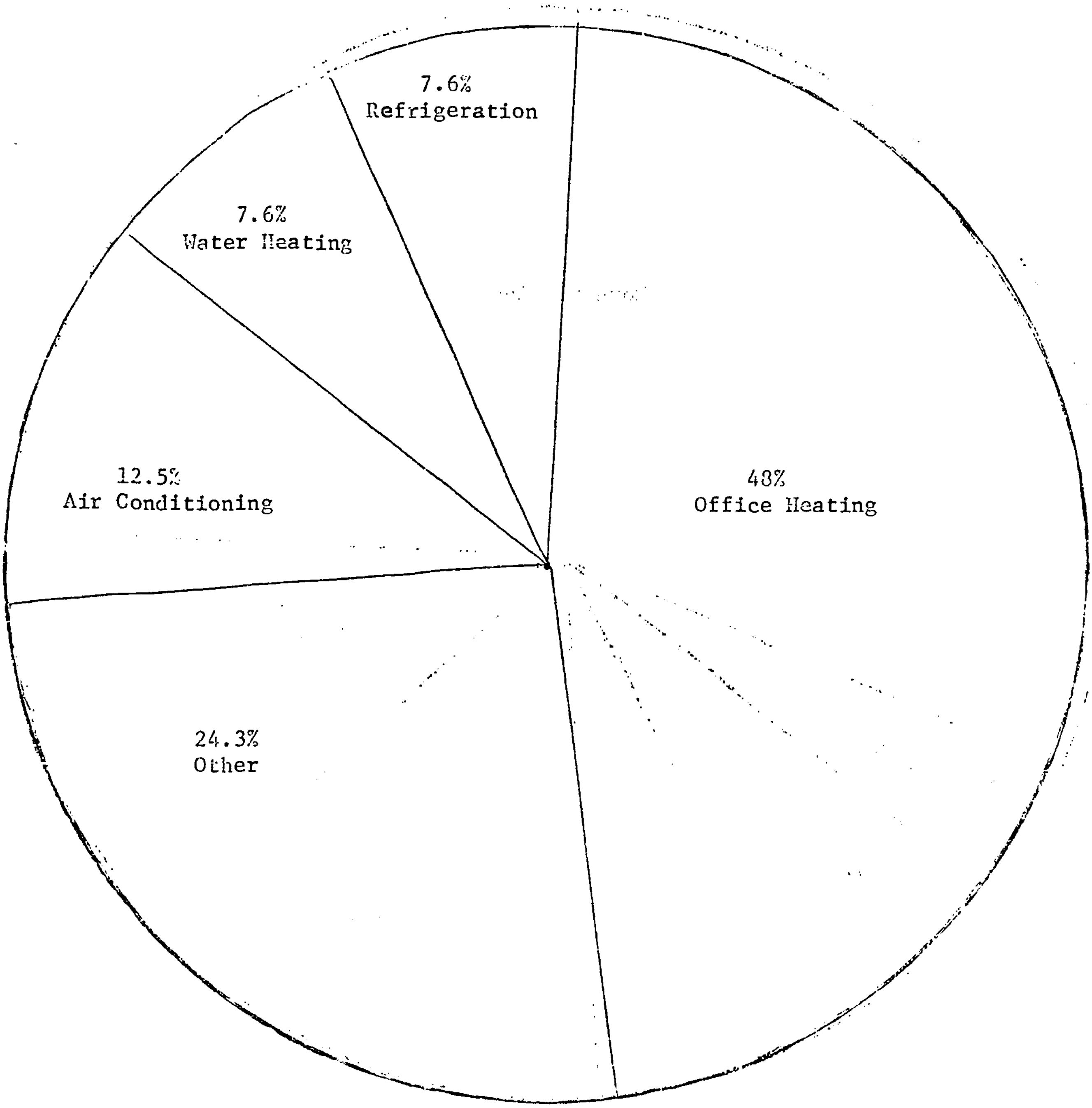
APPENDIX B

Graphs, Maps, and Charts

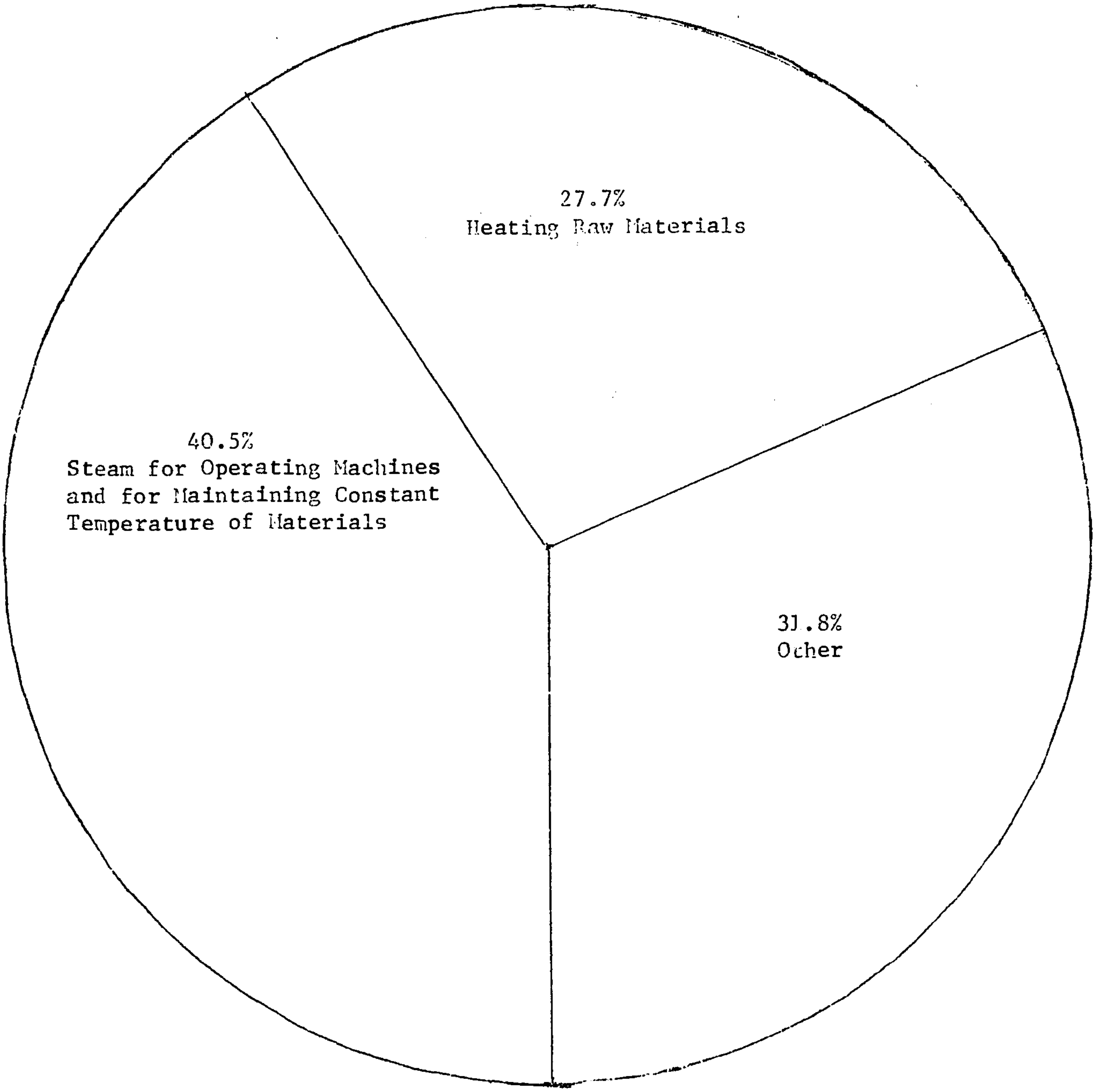
HOME ENERGY USAGE GRAPH



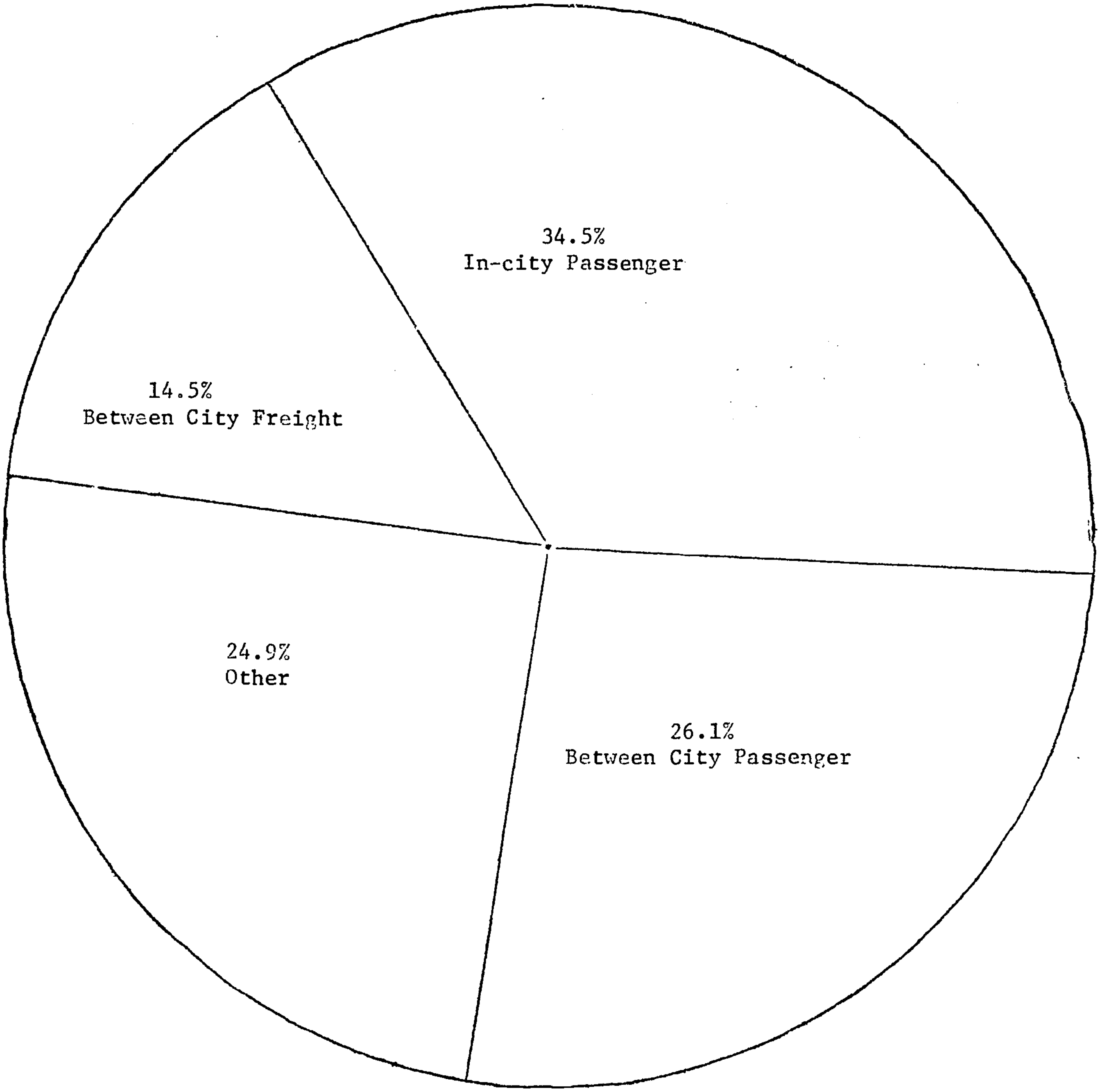
BUSINESS ENERGY USAGE GRAPH



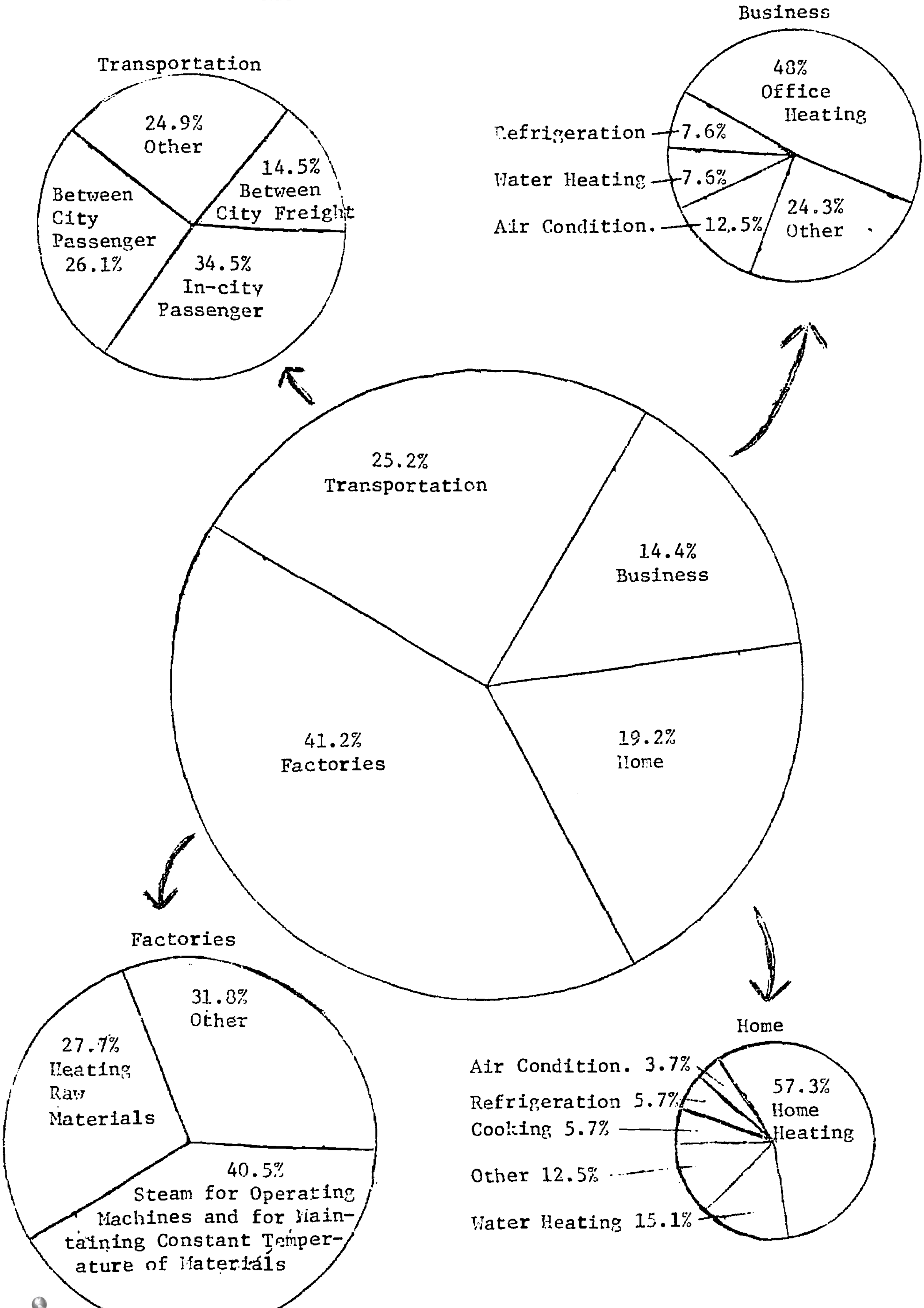
FACTORIES ENERGY USAGE GRAPH



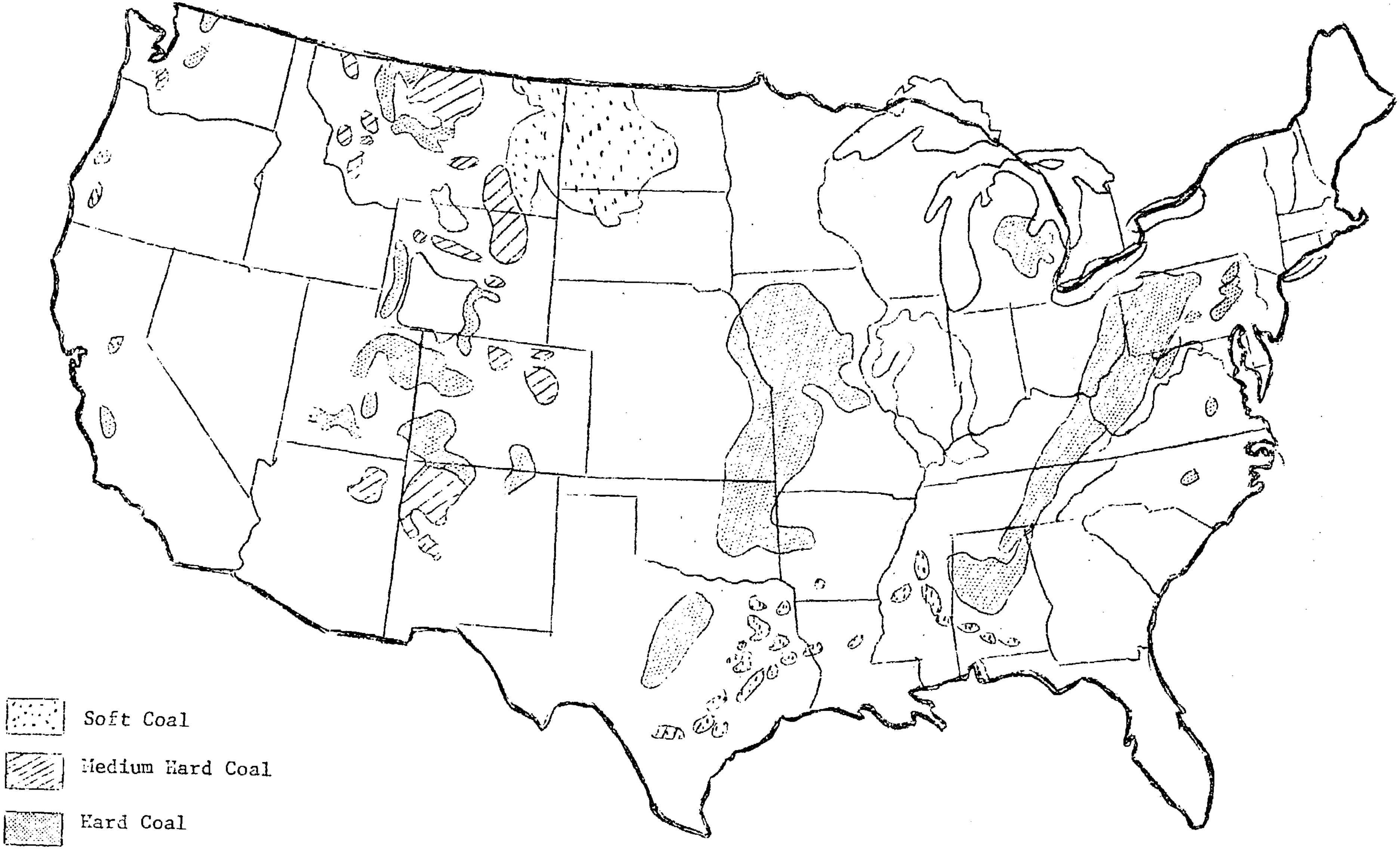
TRANSPORTATION ENERGY USAGE GRAPH



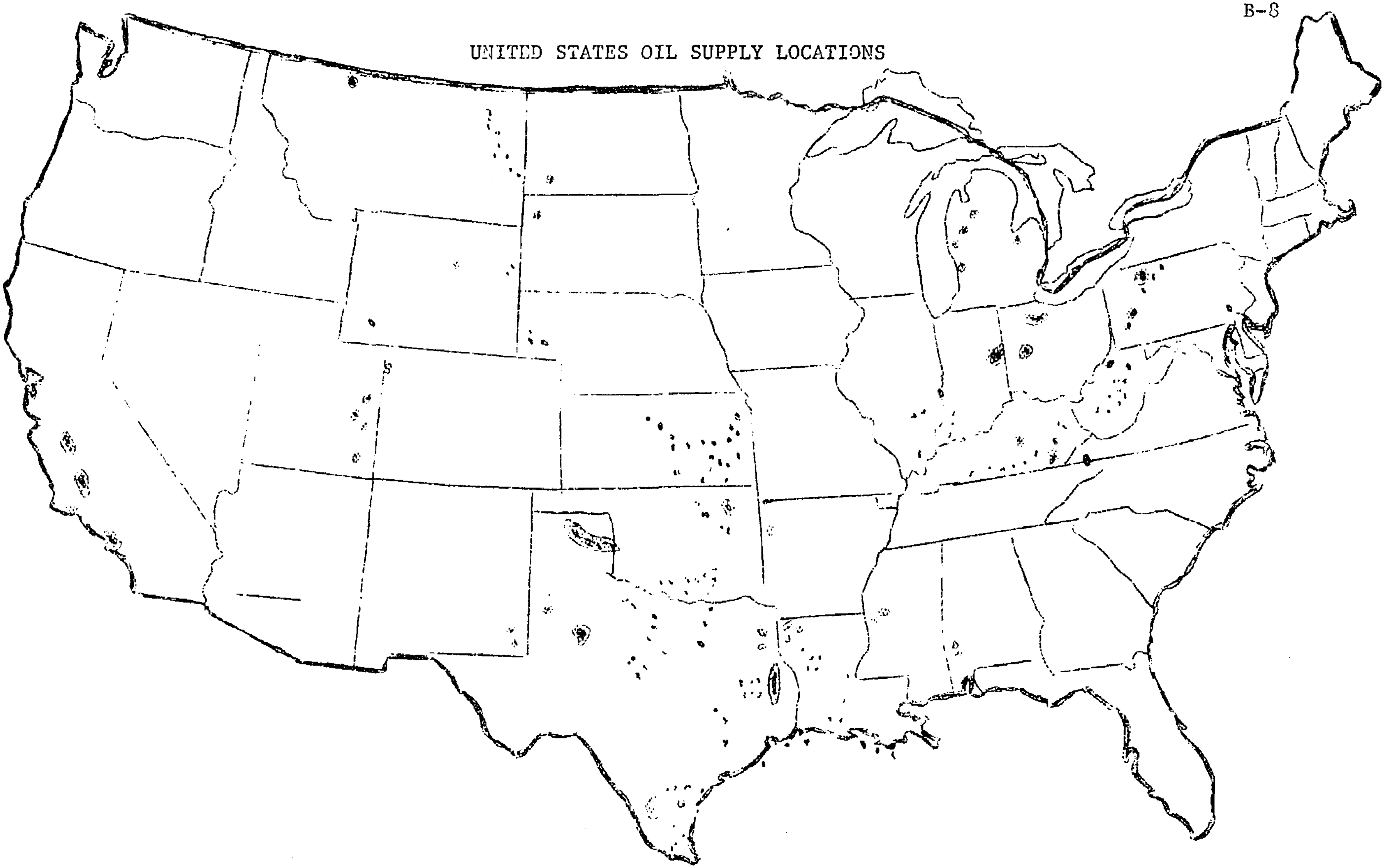
WAYS THE UNITED STATES USES ITS ENERGY



UNITED STATES COAL SUPPLY LOCATIONS

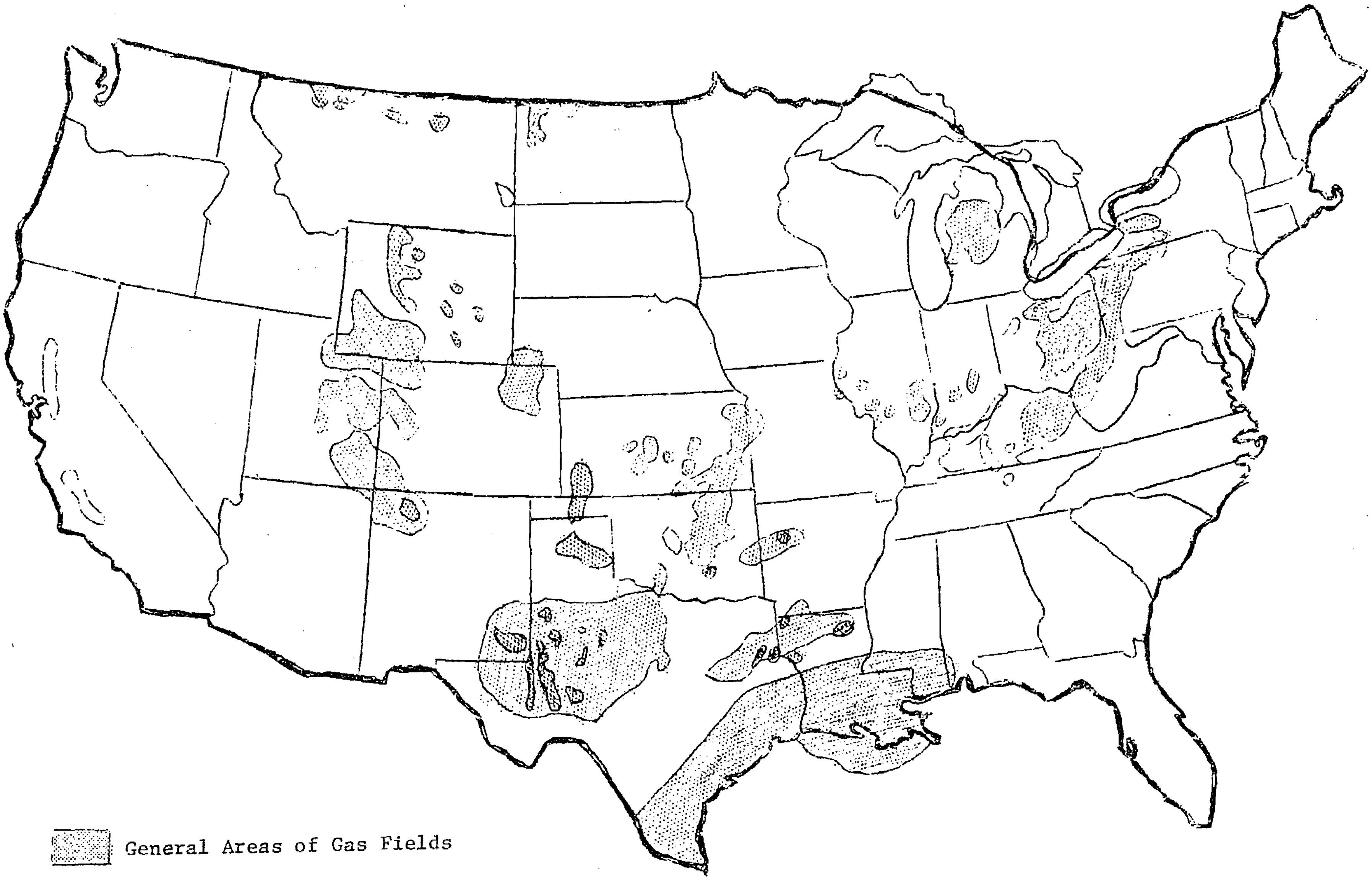


UNITED STATES OIL SUPPLY LOCATIONS

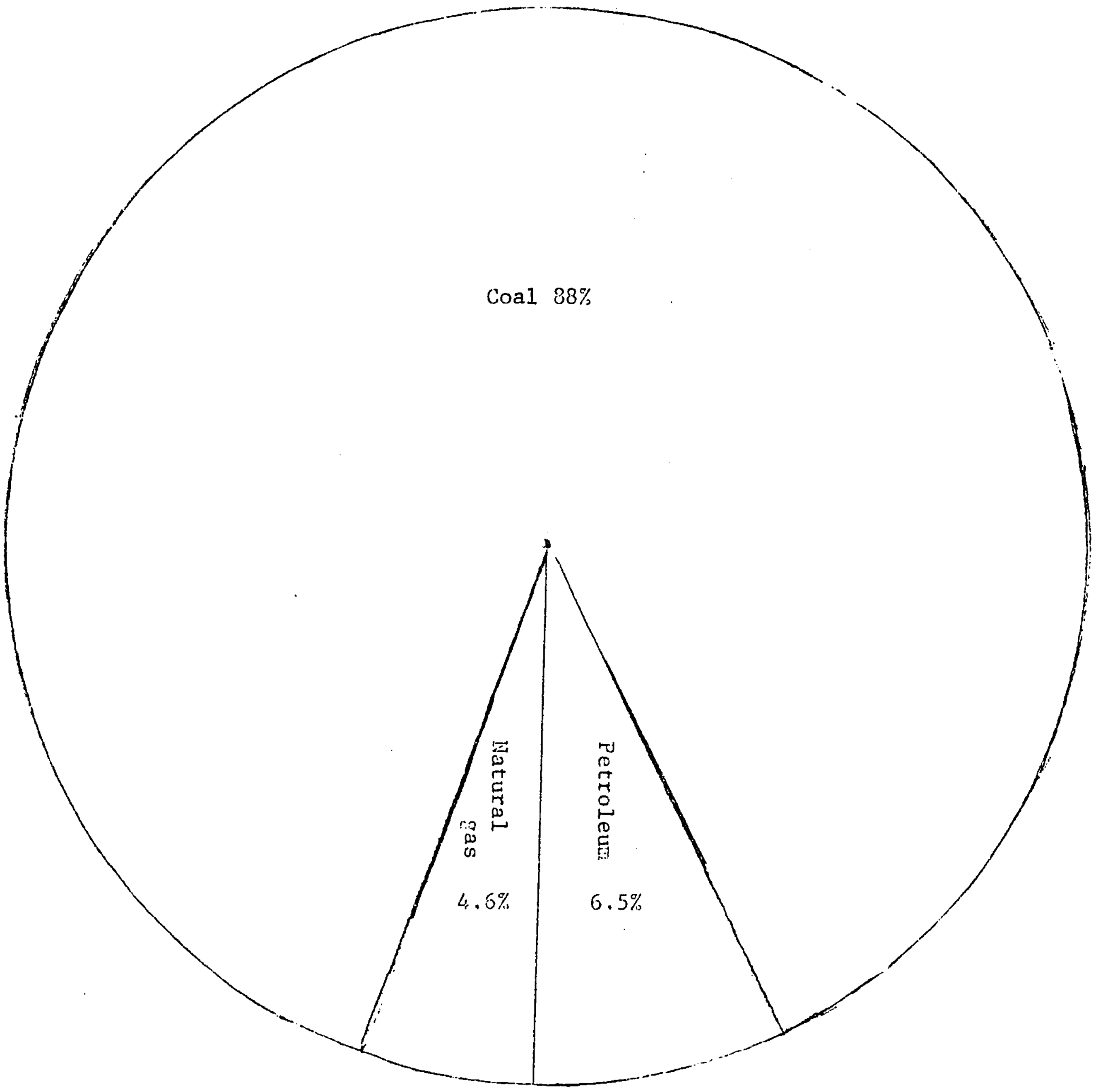


Darkened Areas Indicate Oil Fields.

UNITED STATES NATURAL GAS SUPPLY LOCATIONS

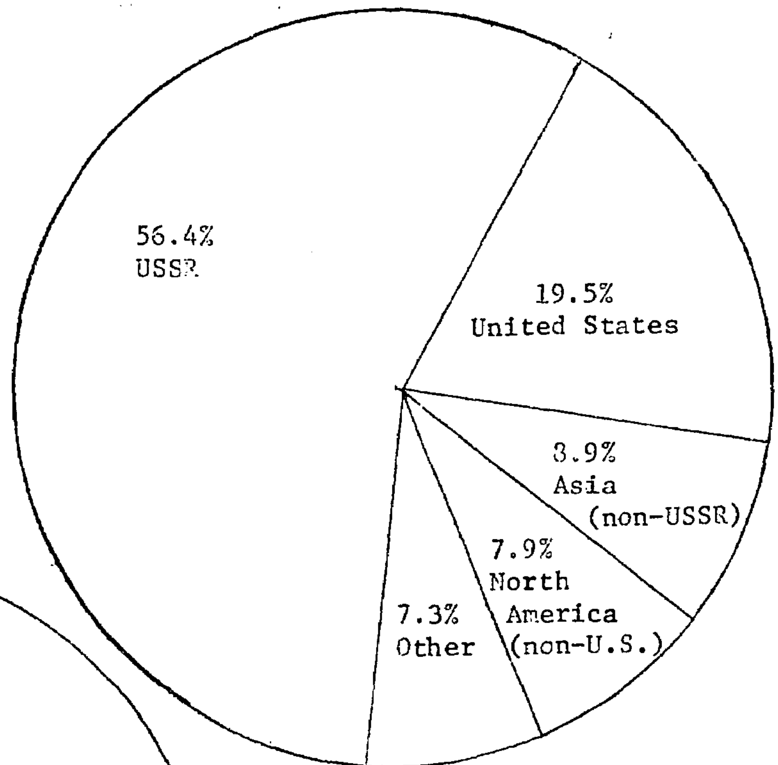


WORLD SUPPLY OF FOSSIL FUEL

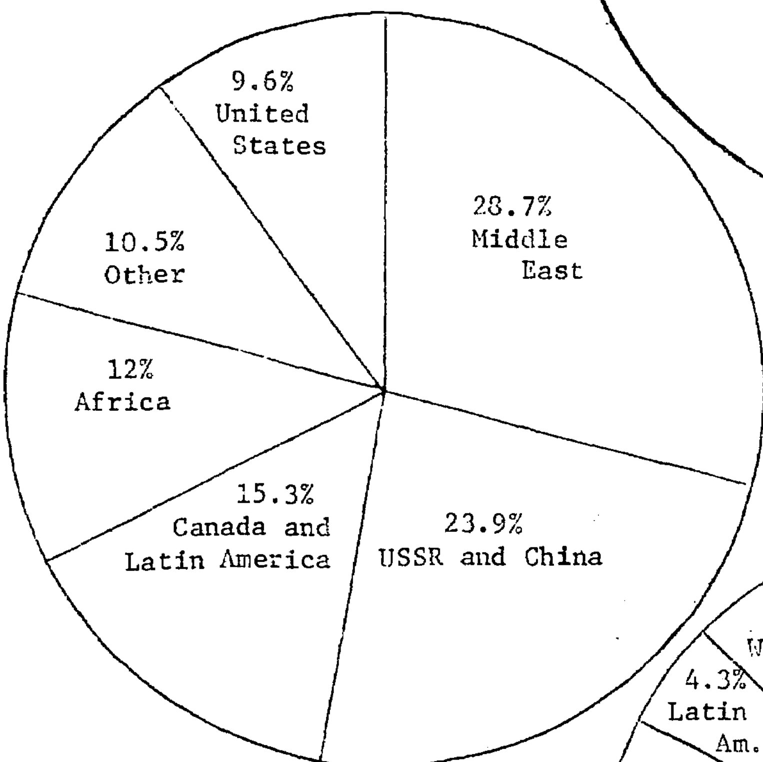


WORLD DISTRIBUTION OF OIL, COAL, AND NATURAL GAS

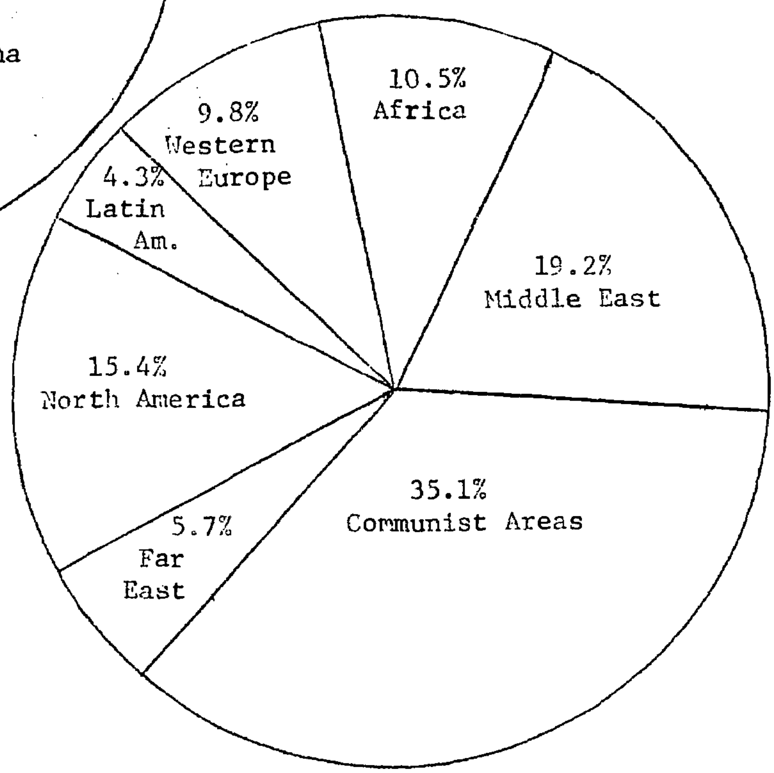
Coal



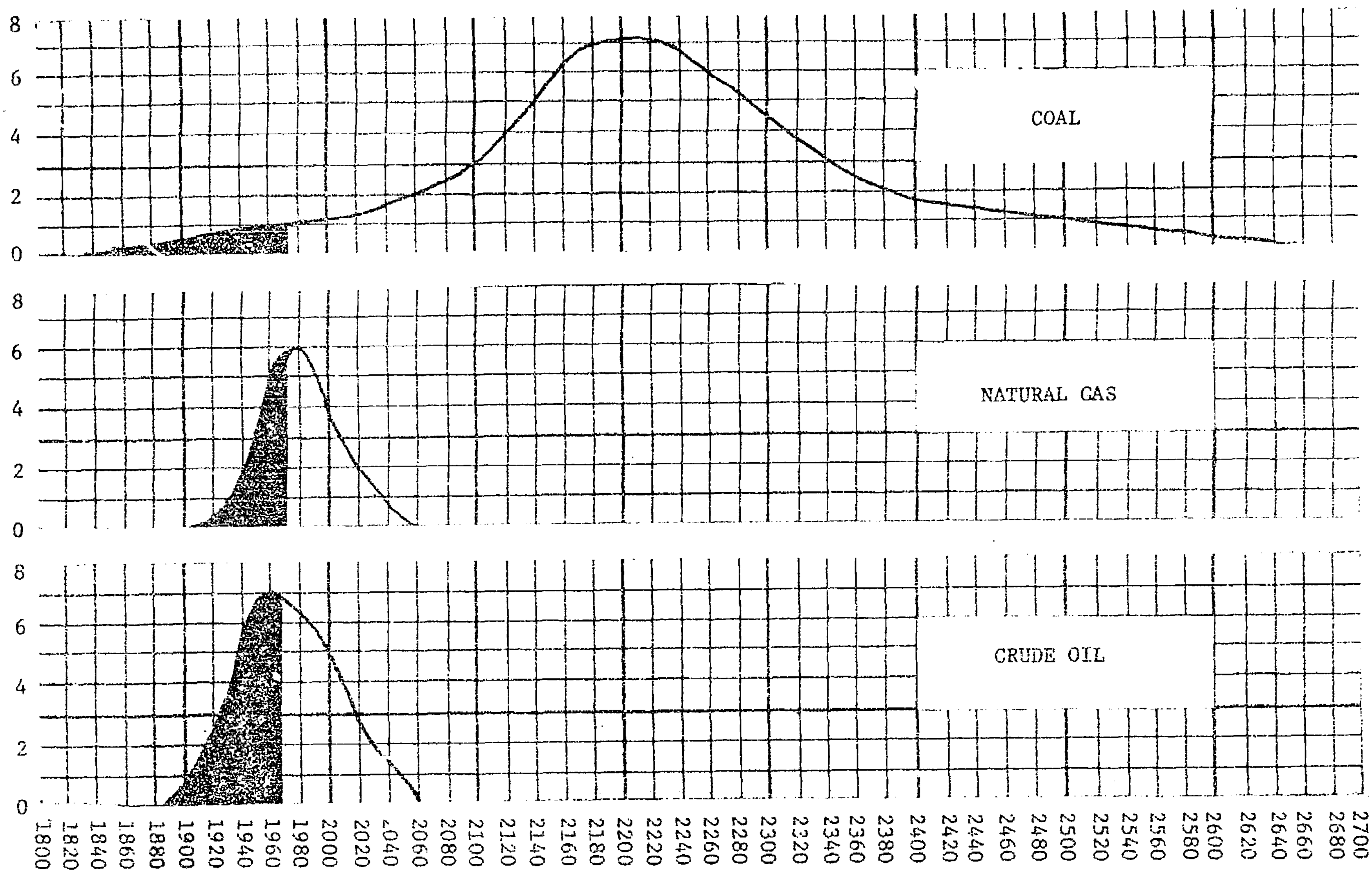
Oil



Natural Gas

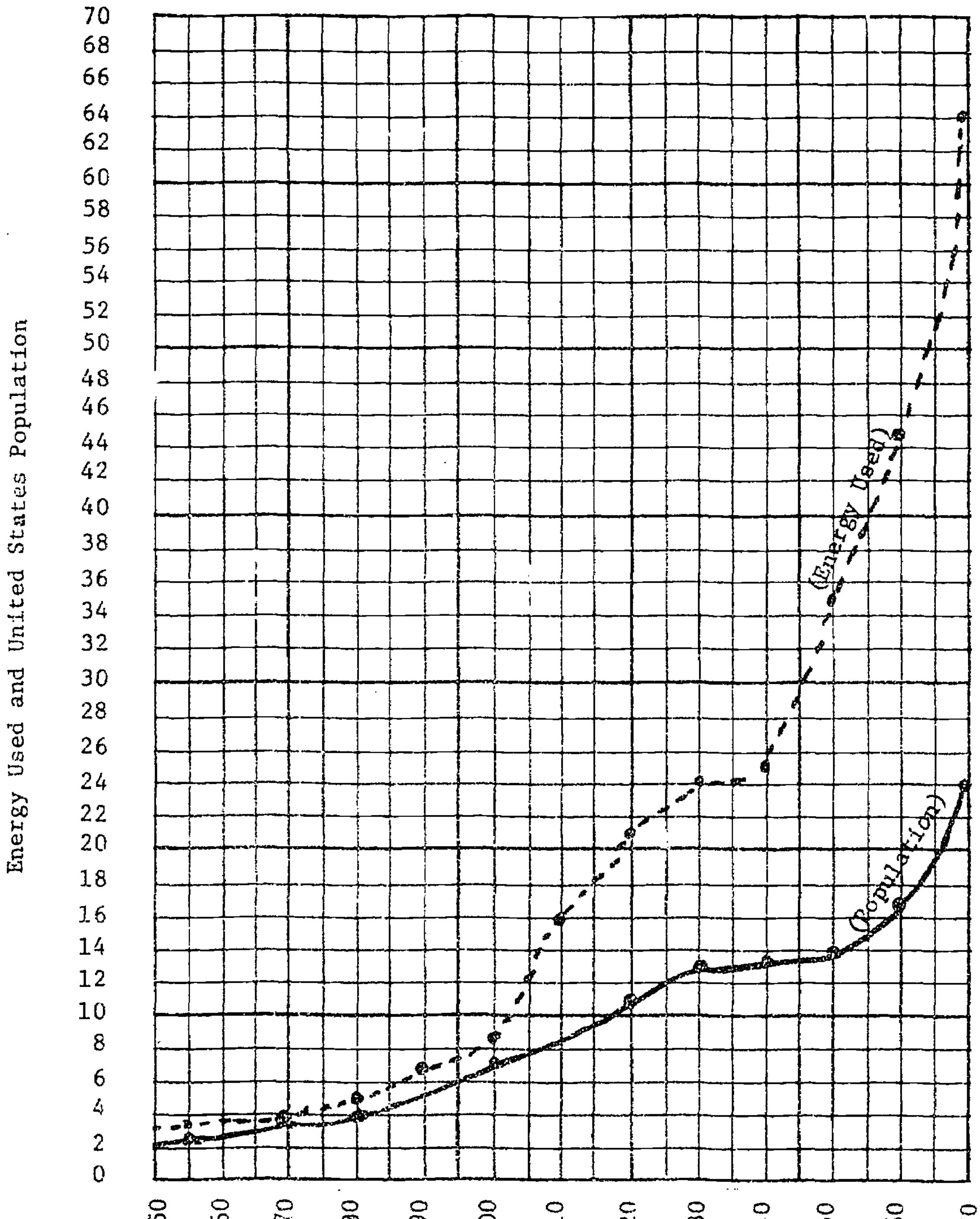


UNITED STATES FOSSIL ENERGY USAGE* AND SUPPLY**



*Dark area represents proportion already used.
**Clear area represents proportion still available for usage.

UNITED STATES POPULATION* AND ENERGY USAGE**



*Multiply the number times 10,000,000 to find population.

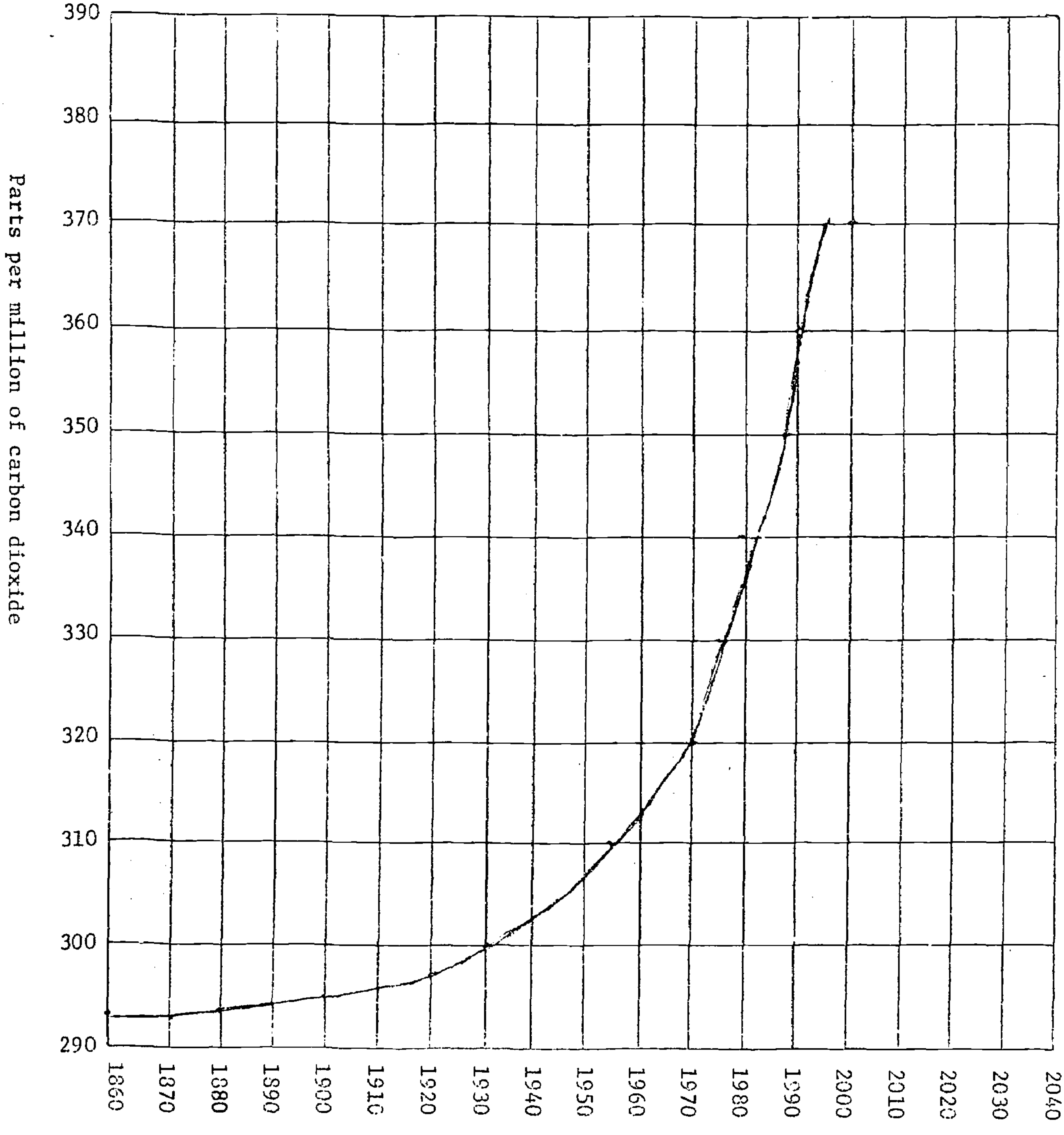
**Multiply the number times 1,000,000,000,000,000 to find Btu's energy.

LIFE-STYLE COMPARED TO ENERGY USED PER PERSON*

Life-Style	Food	Heating	Industry and Agriculture	Transportation
Technological** Man	(10)	(66)	(91)	(63)
Industrial*** Man	(7)	(32)	(24)	(14)
Advanced Agricultural Man	(6)	(12)	(7)	(1)
Primitive Agricultural Man	(4)	(4)	(4)	
Hunting Man	(3)	(2)		
Primitive Man	(2)			

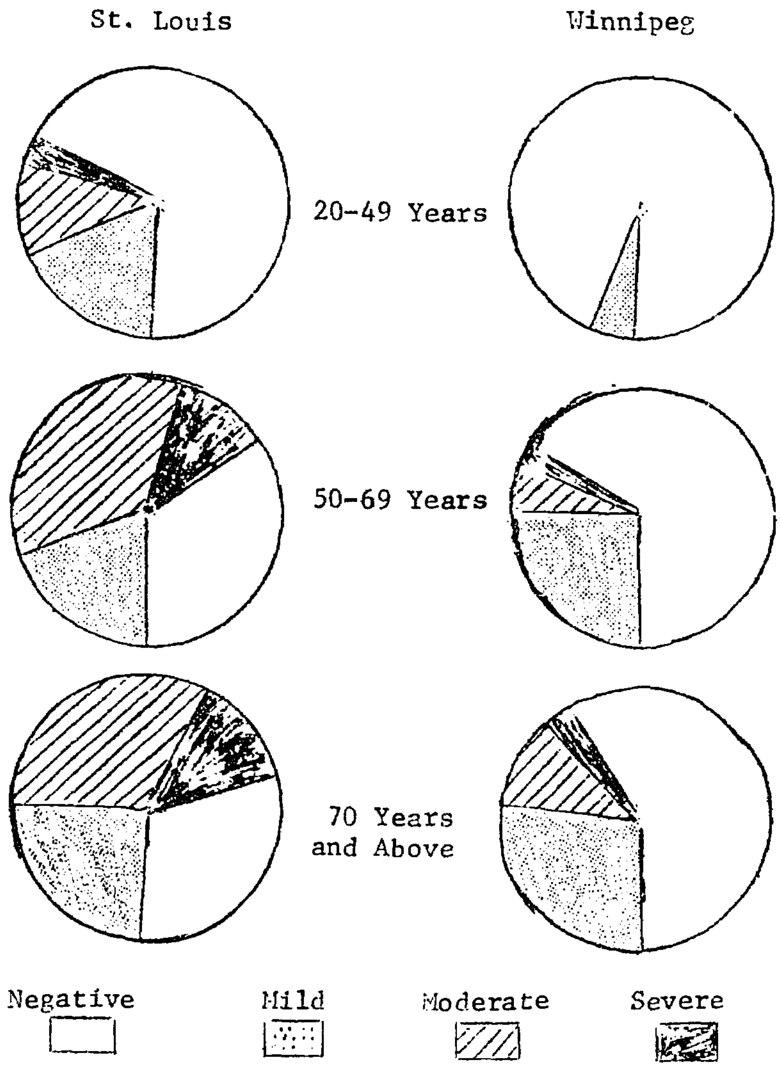
*Each energy unit represents 1,000 kilocalories.
**Represented by the 1970 American life-style.
***Represented by the 1875 American life-style.

CARBON DIOXIDE CONCENTRATION IN THE ATMOSPHERE*



*Measurements and predictions based on Mauna Loa, Hawaii.

EMPHYSEMA FREQUENCY*



Prevalence of Emphysema in Two Cities
with Contrasting Levels of Air Pollution

Prevalence of emphysema, as found in a 1960-66 post-mortem examination of the lungs of 300 residents of heavily industrialized St. Louis, Missouri and an equal number from relatively unpolluted Winnipeg, Canada. The subjects were well matched by sex, occupation, socio-economic status, length of residence, smoking habits, and age at death. The findings clearly suggest a link between air pollution and pulmonary emphysema.

*Source: Air Pollution Primer, National Tuberculosis and Respiratory Disease Association, 1969

APPENDIX C

Short Articles

HYDROELECTRIC ENERGY

The prefix "hydro" comes from the Greek word for water; thus, hydroelectric energy refers to electrical energy from water. About four percent of the electricity in the United States is produced by hydroelectric generating plants.

A hydroelectric generating plant is usually located behind a large man-made dam. Water is allowed to flow through a pipe in the dam and over fanlike blades on a turbine. The moving water makes the fan blades turn. These turbine blades are connected to a generator. This generator produces electricity like any other electric generating plant.

Where did this hydroelectric energy come from and how many different forms does it go through? This seems to be an easy question, but it involves many processes and a lot of energy. First, the water must get into the reservoirs in front of the dam. It gets there by evaporating from oceans, land, rivers, etc. Once it evaporates, it forms clouds which are moved over the land by winds. If the clouds cool, the water falls as rain. Some of this rain water moves along streams and rivers into the reservoir. By this time, the water has needed and used heat energy from the sun, motion energy from the atmosphere, and gravitational energy of the earth.

As the water moves through the dam and over the turbine blades, the energy from gravity is pulling the water downward. The turbine changes the gravitational energy into circular motion energy. As the turbine causes the generator to turn, the circular motion is changed into electrical energy. The electrical energy is transported to homes over wires where it is changed into heat, light or used to run motors.

Hydroelectric power is one of the cheapest forms of electricity and does not cause air pollution. The problems with developing more electricity from hydroelectric power plants are these: (1) Large dams are required. (2) All the best sites for large dams are already used. (3) Dams change the ecology of the rivers where they are built. Today there are over 1,500 hydroelectric power plants in the United States.

As the good sites for hydroelectric power plants are used up, a new type of hydroelectric plant is being built. This new type plant is called a pumped storage power plant. It consists of a reservoir just below the first one. After water flows out of the first reservoir and past a turbine, it is caught in the lower reservoir. At night when people do not need as much electricity, the water in the lower reservoir would be pumped back into the higher reservoir so it could again be used to make electricity. The energy to pump the water back would come from another power plant which also makes more electricity than is needed at night. A pump storage power plant of this type does not require as large an upper reservoir as a normal hydroelectric plant, but requires more land because there are two reservoirs.

HYDROELECTRIC POWER

Questions

1) Where does the phrase "hydroelectric power" come from?

2) Why does the generating of electricity from hydro power cause fewer pollution problems?

3) Describe the process of making electricity in a hydroelectric power plant.

4) How does the energy get into the water?

5) What are the problems preventing us from developing more electricity from hydroelectric power plants?

6) What is different about a pump storage power plant?

GEOTHERMAL ENERGY

The core or inside of the earth is extremely hot. It is believed that this heat results from nuclear type reactions occurring in the material that is tightly squeezed in the earth center. This heat is constantly moving out of the earth into the atmosphere. Usually the amount of heat coming out at any time is so small we do not notice it. There are a few places, however, where the earth's crust is so thin or cracked that this heat is rapidly moving out of the earth. Geysers or other types of steamy water spouts are found in these areas.

In some places, Iceland for example, people have developed ways to capture this heat and use it for cooking, heating homes, heating offices, and producing electricity. In areas where the earth's crust is thin, but not cracked, holes can be drilled through the crust into the hotter layers below. Water is pumped onto the hot layers, causing the water to change to steam. The steam causes pressure which can be used to turn electrical generators. In the United States there are 14 states in which the earth's crust is thin enough that it is possible to drill holes and capture this heat (geothermal) energy. One of the largest potential geothermal fields is located about 75 miles north of San Francisco.

Using the natural heat of the earth appears to be a cheap and clean source of power. Geothermal energy is being used in some places but should not be considered the answer to all our energy needs. There are many environmental problems related to capturing and using geothermal energy: (1) There are only a few geysers such as Old Faithful which have a lot of geothermal energy in one place, so most of the heat energy must be reached by drilling wells and forcing water down onto the hot rocks. (2) Each well can only produce a small amount of electricity so there must be many wells. (3) Generators that change the steam into electricity are very noisy. (4) There is no way of knowing how long a geothermal well will produce once it is drilled. (5) The areas that can be used in capturing geothermal energy are also areas in which there are faults and earthquakes. There is great concern about causing serious earthquakes when the heat is removed from these areas. (6) Most of the areas which would be selected are now being used for farming, industry, cities, or national parks. (7) The steam from the wells has salt and other minerals that must be disposed of without ruining the environment or damaging equipment.

Advantages to using geothermal energy are the following: (1) no dams are needed, such as are needed for hydroelectric power; (2) less air pollution as compared to the burning of coal and oil; and (3) absence of radioactive problems such as from nuclear reactors.

Few countries have yet developed the necessary processes and equipment to use their geothermal energy supplies. As other sources of energy become hard to get, more research will be done on ways to use geothermal energy. Today, it does not appear that geothermal energy will be a big source of power in the United States.

GEOTHERMAL ENERGY

Questions and Activities

1) What does the phrase "geothermal energy" mean?

2) What is the source of geothermal energy?

3) What areas of the earth have places where geothermal energy can be obtained?

4) What are some of the problems that prevent geothermal energy from being widely used?

5) What are some of the advantages to using geothermal energy?

6) Find articles on geothermal energy and share them with others.

7) Draw diagrams illustrating the way geothermal energy is captured and processed.

8) Use the library to do research on the power sources for people living in Iceland. Why are they not using a lot of the geothermal energy available in their area?

9) Why has the use of geothermal energy not been researched and developed in the past?

SOLAR ENERGY

The sun is our greatest potential energy source. It pours 100,000 times as much energy onto the earth as the world's present output of electric power. One method of capturing the sun's energy is through a solar furnace. This furnace consists of a large, curved mirror that collects and focuses the sun's energy into a small area. The mirror acts like a magnifying lens, used to burn a piece of paper. These solar furnaces can reach 6,000°F. In one minute, a 12-inch hole could be burned through a 3/8 inch piece of steel. This heat can be used to boil water, and the steam is used to drive electric generators.

Another method of capturing the sun's energy involves absorbing the sun's heat in liquid-filled pipes. The pipes are arranged so the heat collected by the liquid is used to operate steam turbine electric generators. Eight square miles of collecting area would be capable of producing a million kilowatts of clean, pollution-free power. This is comparable to the output of a typical new nuclear plant.

Others have proposed placing spacecraft with large solar cell panels above the earth. The energy collected by these solar cells in stationary orbit would be sent back to the earth by microwaves. Three big problems prevent this system from working: (1) Today, solar cells cost about four dollars for one cell the size of a thumbnail (25 square miles of cells would be needed to supply just New York City). (2) It would be hard to get the solar cells into space and maintain them. (3) No one has studied the effect of microwave beams carrying thousands of megawatts of energy on the atmosphere and flying objects such as planes.

The greatest advantage to using the solar energy directly is that it is less polluting once the collectors are made. Keep in mind that the energy stored in coal, oil, natural gas, and garbage was captured from the sun and stored by green plants. When we use them for fuel we are really using solar energy, just in a different form.

All three methods of capturing the sun's energy directly are being tested and tried. A large solar furnace has been constructed in France. Several pilot homes have been constructed which trap the sun's energy in water pipes and use it to heat the homes. Solar cells have also been used to help power spacecraft and highway telephones.

Another often overlooked place where the sun's energy has been trapped directly for several years is the greenhouse. When sunlight goes through glass and strikes some object, if changes form and cannot all get back out. This trapped sunlight is changed to heat. This is why you often feel warm if you stand behind a glass through which the sun is shining.

Questions

1) What are some advantages to capturing energy directly from the sun?

2) Describe three of the ways being studied as methods for capturing the sun's energy.

3) What are some of the problems preventing our using more solar energy?

ENERGY FROM WASTE

When living matter dies, it starts to decay or rot. Through this decaying process, gases escape into the air and minerals are returned to the soil for reuse by green plants. By using this natural process inventive persons have developed another source of energy and are helping eliminate our present-day problem of "what to do with our solid waste." These systems are called methane generation. The process is relatively simple and is used in several countries for a small scale energy supply. Any kind of dead plant or animal material can be used to operate the generator. This could be grass clippings, kitchen waste, animal manure, etc. The material is placed inside a large sealed tank so no air can enter. Water is placed in the tank until the mixture is like thick soup. A certain bacterium that can live without oxygen starts eating the material and releasing methane gas. Methane gas is much like natural gas and can be used for home heating, running engines, etc. The methane gas is collected and piped to wherever it is to be used. The material left after this process makes a good fertilizer.

There are several problems currently associated with this type of energy production: (1) Temperatures must be carefully controlled for the bacteria to live. (2) Several days are required for the process to occur. (3) The mixture must be constantly mixed. (4) Technology has not been developed to make this an efficient system. (5) Getting waste and garbage collected and separated from nonusable material such as glass, iron, etc. requires new systems.

Many city sewage treatment systems like Topeka use a similar process in treating the solids from sewage. The Topeka system uses the methane gas to power their air pump engines.

With growing concern for energy, research on ways of improving the methane generators is being conducted at many locations including Kansas State University in Manhattan. It is predicted that by using manure from cattle feed lots, and other agricultural waste materials, 13 percent of the demand for electricity in Kansas can be met from energy produced by methane generators. At present, the methane would cost around 72 cents per one thousand cubic feet, compared to natural gas costing 25 - 35 cents per one thousand cubic feet. In two years natural gas may increase to one dollar per one thousand cubic feet. If this occurs there obviously will be more interest in developing methane generators.

In 1972 St. Louis, Missouri began grinding part of their trash into very fine material. This ground up trash was mixed with pulverized coal and used as fuel to generate electricity. This is an odorless and clean-burning fuel. Every ton of trash used saves one-half ton of coal. Several European cities have been using their trash to generate electricity for many years.

In Nashville, Tennessee 360 tons of the city's garbage is being used to generate power each day. This is enough energy to heat and air condition 27 office buildings for a year. This process reduces the amount of land needed for landfills and reduce air pollution problems.

Waste from homes and agriculture, that can be used to produce energy, amounts to about sixty-five pounds per person each day. This amounts to 2 1/2 million tons of waste material each year. If this waste was used to generate electricity, it would supply over one-half of our present need.

ENERGY FROM WASTE

Questions

1) Where does the energy in dead plants and animals come from?

2) How does a methane generator operate?

3) How can we use methane?

4) Where are methane type generators now used?

5) What are some of the problems with operating methane generators?

6) What is another way we can get energy from garbage?

7) What is now being done with this waste material?

8) How much of our energy needs could be meet by turning waste into electricity or methane.

NUCLEAR ENERGY

Many people believe that nuclear power from radioactive fuel will be the answer to our energy demands. Some of our present electrical energy supply comes from nuclear generators, but only a very small percentage. These nuclear generators are not being built faster because of technological problems and the public fear of radiation exposure in case of an accident.

There are three possible types of nuclear reactors: the fission reactor, the breeder reactor, and the fusion reactor. All three types produce heat used to change water into steam which turns a generator just like in a typical coal powered electrical generating plant. These nuclear reactors all depend on changes in the nucleus of atoms.

The nuclear plants in operation today are of the fission type. A small amount of the radioactive element uranium-235 is placed inside a tube where it breaks apart into other elements releasing heat. The released heat changes water, which is outside the tube, into steam. This steam then is used to turn a turbine. One golfball size sample of uranium-235 contains as much energy as 15 train car loads of coal.

This sounds like a clean and neat way to generate electricity. However, some of the problems with fission generating plants are these: (1) only enough uranium-235 exists to power this type of electrical generator for about 30 years, (2) the waste material left after the uranium-235 is used up is very radioactive and will remain so for many many years and must be stored in a safe place, (3) only a small percent of the uranium-235 energy is changed into electricity, and (4) there is a danger of radiation leakage from the reactor itself.

Extensive research is being done today on the breeder reactor, the first model of which was built in 1951, in hopes that it will solve many of the problems of the fission reactor and produce our needed electricity. The breeder reactor differs from the fusion reactor in that it produces heat from a different kind of uranium and the uranium used causes a more usable radioactive substance to be formed. This means it is always making more fuel than it is using. Other advantages of the breeder reactor over the fission reactor are that (1) it is more efficient (more of the energy in the uranium is changed into electricity), (2) the waste material is not as dangerous, and (3) it operates at lower temperatures and pressures, thereby reducing the chance of radiation leakage due to accidents. The big problem with the breeder reactor is that it is very difficult to control the reaction producing the heat and the reaction destroys the equipment containing the reaction.

The third type of nuclear power is the fusion reactor. It is the scientist's dream for the future. It operates on the same type of reactions as the hydrogen bomb. The fusion reactor would combine hydrogen atoms to make Helium atoms producing large quantities of heat. This is the same way the sun produces its energy. For hydrogen atoms to be joined, they must be heated to a temperature around 100 million degrees. To date, this reaction has not been done in a controlled laboratory so it will produce more energy than it requires. The hydrogen needed for the fusion process can be taken from sea water. The potential energy of the amount of hydrogen in one gallon of water is equal to the energy in 300 gallons of gasoline. Scientists feel sure that some day they will be able to control the fusion reaction and harness it for our electrical supply.

Many people are fearful of anything to do with nuclear radiation. This fear may come from the bombs dropped in Japan and/or from the fact that one cannot see or feel radiation until it has caused damage. One of the biggest problems builders of nuclear powered plants must overcome is this fear of radiation. Other problems developers must overcome are (1) some waste from the power plants can remain radioactive for 100,000 years. This is longer than any one form of government has existed, so how can we control the wastes? (2) 150 nuclear power plants could produce more longlasting radioactive waste than 130,000 Hiroshima bombs; (3) one mistake at a nuclear power plant could endanger many people's lives; (4) strip mining for uranium ore causes the same type of environmental problems as coal mining; (5) waste material around uranium process plants contains radioactive radium which can be dangerous in higher concentrations; (6) most insurance companies limit or refuse to cover damage resulting from nuclear power plants; (7) radioactive waste material from nuclear power plants can be used in making bombs. This could be very dangerous in the hands of the wrong people or countries; (8) nuclear power plants are vulnerable to sabotage and blackmail; and (9) the long-term safe level of exposure to radiation is not known.

Questions

1) How much of our electricity presently comes from nuclear generators?

2) What are some of the reasons we are not building nuclear generators faster?

3) What do all three types of nuclear generators have in common?

4) Which type of nuclear reactor do we now have in operation? How does it operate?

5) What is different about the breeder reactor?

6) Which type of nuclear generator do scientists believe will eventually produce most of our power?

7) What are some of the problems associated with operating nuclear power plants?

ENERGY FROM WIND

Moving air (wind) contains great quanities of energy. The biggest problem with capturing the energy of wind is, it is spread over the entire world and not concentrated in a few locations.

Man has been aware of the energy contained in wind for a long time and has captured some of it through the use of windmills. The windmills provided the energy to pump water, grind grain, and make small amounts of electricity. For example; before abundant supplies of gasoline, diesel fuel, and electricity were available to settlers of Western Kansas nearly everyone had one or more windmills. In 1915 there were 3,000 windmills in Denmark producing electricity.

As the need for energy grows and our present sources are disappearing, people again are expressing interest in developing ways to trap the energy of wind. In the United States, the winds of the Eastern Seaboard, the Aleutian Islands, Texas Gulf Coast, and the Great Plains are the most constant and offer the greatest possibilities as sources of energy from wind. It has baen proposed that 5,000 large windmills floating offshore could supply the energy needs of the city of New York.

The many problems involved in capturing the wind's energy make it seem unlikely wind will become a major source of energy in the near future. Some of the problems are: (1) Large windmills are hard to maintain and take up much space. (2) Wind does not blow constantly. (3) Only a few places have strong enough winds to power electrical generators. and (4) A large number of wind powered generating stations could interfere with local winds causing a change in weather patterns.

Questions

1) How has energy from wind been used?

2) Why did we stop using windmills?

3) What are some of the problems in capturing the wind's energy?

ENERGY FROM TIDES

Tides are large moving bodies of water resulting from the pull of the moon's gravity and the rotation of the earth. Moving water contains a lot of energy; For example, think about all the damage floods can cause. The problem is trapping the energy from tides and changing it into electricity or some other form which can be transported to where it is needed. If all the energy estimated to exist in the tides could be captured, it would provide us with three times our present demands.

There are places along ocean shorelines where the water level changes many feet between high tide and low tide. These are the most promising locations for capturing the energy in tides. Present tidal power plants consist of a large dam across a river mouth near the shoreline. Electrical generators and turbines are placed in the dams. At high tide, water moves through the turbines and fills the reservoir behind the dam. During low tide, water empties out of the reservoir through the turbines into the ocean. As the water moves through the turbines it causes the generators to turn and make electricity just like in a hydroelectric plant.

The problems with tidal power plants are: (1) Only a few locations have great enough difference between high and low tides to move large volumes of water in a small area. (2) The dams cause great ecological problems to ocean life whose life cycles depend on the areas trapped behind the dams. and (3) Salt water corrodes the generating equipment.

Only two full scale tidal power generating plants are in operation. One tidal plant is located on the Coast of Brittany of France and the other at Kislaya Cuba in the Soviet Union. Many other small experimental tidal power plants have been constructed over the world.

Questions

1) What is the source of energy in the tides?

2) Why can only a small amount of the energy in tides be captured?

3) What kinds of conditions are necessary if we are to capture tidal energy?

4) How does getting energy from tides differ from getting electricity from hydroelectric power plants?

5) What are some of the problems preventing us from building more tidal power plants?

GASIFICATION OF COAL

Coal is presently our greatest source of energy from the fossil fuels. Coal contains carbon, hydrogen, oxygen, nitrogen, sulfur, and mineral ash. The best coal supplies are those that contain mostly carbon and hydrogen. This harder type coal (anthracite) is found deep underground. At our present rate of energy usage, we have enough coal to fill our energy needs for at least one-hundred years.

One of the problems with using coal as an energy source in our homes, factories, and power plants is it produces air polluting substances (for example, sulfur) when it is burned. Sulfur compounds combined with water form an acid. This acid can damage plants, metals, building materials, and animal lungs. Present pollution control devices can control much of this problem.

One method for getting energy from coal without so many pollution problems is through gasification of coal. In a coal gasification plant coal is placed in a closed container and heated to about 1,000°F. and sprayed with hot steam. The hydrogen from the steam combines with the carbon in the coal to form methane gas. Methane gas burns clean like natural gas and can also be changed into gasoline, diesel fuel or oil. The gasification plant traps sulfur and other pollutants. These pollutant materials can be processed into useful chemicals.

Presently gasification of coal is being done experimently to improve the heating capacity of the gas. However; the process of gasification was used before we had natural gas. Topeka used this process to produce a gas called "town gas."

Questions

1) Why have we not used more coal to supply our energy?

2) What does the word gasification mean?

3) How is coal changed into gas?

4) Why do we want to change coal into gas?

5) What will we do with the gas made from coal?

OIL SHALE

Not all oil can be removed from the earth by pumps and oil wells. A lot of oil, up to a trillion barrels, is contained in a soft rock throughout the world called oil shale. The richest supply of oil shale in the United States is located in the area where Colorado, Utah, and Wyoming meet. This area is a thinly settled, semi-arid, wilderness with a rough terrain used for ranching, and hunting. The lack of water prevents the area from being settled and farmed.

The oil containing shale was formed after the dinosaurs were living on earth. It is believed that the shale was formed as sediment in the bottom of a large lake that covered much of the three state area for many thousand years. About 1/100th of an inch of shale was formed each year. The present shale deposit varies from a few feet to several hundred feet thick. In some areas, the oil shale is exposed on the surface, while in other areas the shale is covered by as much as 1,500 feet of soil. Many other valuable minerals are also mixed in with the oil shale. Aluminum, table salt, and baking soda are examples of materials that can be extracted from other minerals found in oil shale.

Scientist have known about oil shale for many years. Only in recent years due to our greater and greater demands for oil has anyone seemed interested in developing ways to remove the oil from the shale. The process for removing the oil from the shale is much more difficult than pumping oil from wells.

The oil shale is mined, crushed, retorted, and upgraded then it follows the normal oil refining processes. Strip mining can be used if there is only a little soil on top of the shale. If the shale is deep below the surface, underground mining methods are used. After the shale is removed from the ground, it is crushed into small particles. The ground-up shale is placed in a retort or oven and heated to 900° F. The heating causes the oil to evaporate from the shale and it can then be collected. This first oil collected must be upgraded or processed to removed sulfur and nitrogen before it can be sent to the refineries. At the refineries, the oil is processed the same way as oil from wells.

In addition to further developing the equipment for removing the oil from shale, other problems must be studied and solved before oil shale will be an important source of oil. Some of these problems are: (1) Many different people own mineral leases in the areas containing oil shale. Their minerals will often be destroyed when the shale is mined; (2) What affect will the mining have on the geology of the area? (3) Mining would bring more people to work the mines. How will this increase in population being served? (4) Who will provide the public services (schools, sewage, water, power) for the mining workers? (5) What will happen to the wildlife that presently lives in the area? (6) The oil shale expands like pop-corn when heated. Where will the waste shale material be placed? (7) Where will roads, pipelines, and powerlines be located? (8) Where will water needed for mining be obtained? (9) What is to happen to the area after the mining is over and the miners move out? and (10) What will the oil cost that is removed from the oil shale?

Using oil shale is not a new idea. The Colorado Ute Indians burned oil shale in campfires for firewood. France, England, and Scotlend have at various times used oil shale as a source for oil. Russia and China are presently using oil from oil shale.

OIL SHALE

Questions

1) Why has the United States not been using the oil from oil shale?

2) Is oil shale only found in the United States?

3) What are some of the problems related to mining the oil shale?

4) How does getting oil from oil shale differ from our present ways of obtaining oil?

5) How many years would it take to form a layer of oil shale 50 feet thick?

6) What is the area in Colorado like where the oil shale is found?

7) What would you say is the biggest problem holding up producing oil from oil shale?

8) How are the products from oil used in our daily lives?

9) What would you suggest doing with the shale after the oil has been removed?

10) Find pictures of the oil shale area to show others.

11) Make a collection of articles discussing oil shale.

12) Do you think oil from oil shale will become an important source of energy? Why?

BLACK LUNG - The Miner's Peril*

Imagine you are a coal miner in the Appalachian mountains. You enter the mouth of a dark, underground, bituminous coal (soft coal) mine. You're aboard a huge machine that chews into the coal seam (vein). You're opening up territory no one has ever seen before. You go farther and farther underground. As you go deeper and deeper, coal dust falls on you like a black mist. You see it on your clothes. You feel it on your skin, and in your eyes. The dust gets into your mouth, your ears, and into your lungs.

You've been a coal miner for many years. As time has passed, you've found it more difficult to do your work. You're coughing a lot, walking more slowly, and you have difficulty breathing. And you never stop spitting up coal dust.

You're worried, because your family depends on your income. But now you may have to stop working. Why? Your doctor thinks you may have black lung disease. You're not alone. The doctor told you that in your working area, one out of every 10 men has the same symptoms.

This is the story of thousands of men working U. S. coal mines. At least 125,000 men have been stricken to some degree with black lung. And at least 4,000 men die from it each year. But in Britain, another great mining nation, black lung disease is much rarer.

What is black lung, and why do so many American miners, and not British miners, come down with it?

Let's first get a closer look at the main target of coal dust--your lungs. Your lungs are the most exposed internal organs of your body. During each minute of your life, you breathe in air about 20 times. (Try timing yourself, and see.) And each time you do, you fill your lungs with the natural elements of air, such as oxygen and nitrogen. But you also breathe in other things--objects that are floating in the air--such as dust particles.

Your body, however, wages a steady battle against the "garbage" you take in with each breath.

To find out how this battle is carried on, let's follow a tiny particle of dust down into your lungs and see what happens to it. First, the bit of dust moves through your mouth into your trachea (TRAY-kee-ah)--"windpipe." The particle must be a small one, or the trip might end right here--with a cough. Anything too larg or too irritating automatically trips your "cough reflex." When this happens, your lungs contract strongly, expelling air and the irritating bit of dust.

If the particle is not coughed up, it then flows into one of two tubes called bronchi (BRON-kee). Each leads to a lung. These airways branch off repeatedly into thousands of smaller and smaller tubes. Physiologists (scientists who study body processes) call this intricate network the bronchial tree. At the very tips of the smallest tubes are tiny air sacs called alveoli (al-vee-OH-lee). That is where the oxygen you inhale passes into your blood and where the carbon dioxide you exhale passes out of your blood.

*Science World---October 11, 1971, pages 2 -..

The tubes in the bronchial tree are lined with a special layer of tissue called bronchial epithelium (ep-ee-THEE-lee-um). Certain cells in the epithelium pour out a sticky fluid called mucus. Other cells have tiny hair-like "fingers" called cilia (SILL-ee-uh). These cilia constantly wave like a field of wind-blown grain.

Now let's watch that dust particle. After it enters the bronchial tree, it swirls through tubes that become smaller and smaller in diameter. What is likely to happen? At one time or another on its trip to the alveoli, the dust particle probably touches the wall of one of the tubes. As soon as it does so, it is trapped in the sticky mucus.

Now the cilia take over. The hair-like whips continually beat the mucus and its load of dust upward. The effect is like a "mucus escalator," with the tiny cilia supplying the power. Particles on this escalator ride upward at a speed of a few centimeters a minute. Finally, they reach the mouth, where they are swallowed or spat out.

Let's assume, however, that the dust particle is extremely small (about one micron or 1/25,400 of an inch in diameter). At this size, it is possible for the particle to wind all the way through the bronchi and reach the alveoli.

When the bit of dust arrives in the alveoli, special cells called phagocytes (FAG-oh-sights) go into action. These cells "wander" all over the walls of the alveoli. When they "bump into" a bit of dust, they surround and "swallow" it. Then, carrying their cargo of dirt, the phagocytes move to the bronchi, where they are whooshed upward by cilia.

If you're a coal miner, you may inhale a great amount of dust each year--more than your phagocytes can "capture" and get rid of. Therefore, the coal dust particles build up in and clog and damage your alveoli. And as this dust builds up, your lungs gradually change from their natural pink color to black. Why Black? The main substance of coal is carbon, and carbon is as black as an unlighted mine.

As more and more dust builds up, your lungs can't deliver as much oxygen to your body as they used to. Also, your lungs are more likely to become infected, and more likely to become diseased.

Black lung disease, called pneumoconiosis (NEW-moe-koh-nee-OH-sis), from the Greek words pneumon, "lung," and konis, "dust," is such a disease. And when black lung strikes, its victim becomes breathless, coughs, and spits up dust. He tires easily and finds it difficult to work. Eventually, he may get lung cancer or another serious lung disease that can kill.

Black lung disease is not new. In the early 1900's, doctors first noticed that coal miners were dying at an early age. And when the doctors examined the lungs of the dead miners, they found the lungs were black. But people hesitated to blame the deaths on coal dust. Then, in 1942, British scientists pinpointed the cause of black lung--coal dust. And the British went into action.

Because it is an occupational disease (caused by the person's occupation), in 1943, Britain made black lung compensable. That meant that workers who got black lung would get paid, even though they could no longer work. And if they died because of the disease, their widows would also get some money. But the British government was also interested in preventing and detecting black lung disease before it caused harm.

Every few years in Britain, miners are X rayed. The amount of coal dust in mine air is controlled by special machines. According to Dr. Gough, Head of Department of Pathology and Bacteriology of The Welsh National School of Medicine, Cardiff, Wales, this is the most important measure taken, because "...the more one reduces the dust, the less disease there is."

In 1959, Britain reported that 13.5 percent of the coal miners had black lung disease. Now, due to research and technology, fewer than 12 percent have it.

However, according to Dr. Lorin E. Kerr, Director of the Department of Occupational Health, United Mine Workers of America, in Washington, D. C., the picture is not as good in the U. S. Dr. Kerr says, "I have reason to believe that as high as 20 percent of the working coal miners have black lung disease." What's more, at least 4,000 miners and ex-miners die each year because of black lung.

Why is the U. S. lagging behind Britain in controlling black lung disease?

Until 1969, few people in the U. S. seemed to be aware of black lung disease--or few listened to the pleas of miners and their organizations. Very few doctors in the U. S. could even identify the disease. In Britain, in 1942, because of years of concern and research, the time mine workers were allowed to spend on a dusty job was limited to only a few hours per day. In the U. S., there was no such limit. Measures were taken in Britain to control the amount of coal dust in the air. Few were taken in the U. S. British doctors regularly examined the workers. And those that did get black lung were relieved from work, but still got paid. U. S. miners were not treated this way.

Because of the hard work of the people in the Department of Occupational Health, the United Mine Workers of America, and especially Dr. Kerr, a law was finally passed in the U. S. in 1969. The Federal Coal Mine Health and Safety Act of 1969 has just begun to protect the health of our coal miners.

U. S. Scientists have begun research to find out how to treat and prevent black lung. Eight hundred doctors from across the nation have attended special lectures held by the American College of Radiology. These sessions train doctors to identify black lung from X-ray pciture s.

Examination of all American coal miners has begun. And miners stricken with black lung, and widows of victims of black lung, are now paid certain amounts of money by the U. S. government. By the end of 1971, Dr. Kerr estimates, 330,000 miners or their families will be getting "black lung" pay.

But many miners are unhappy with the Coal Mine Health and Safety Act. Why? In order to get black lung sick pay, X-ray pictures and a special breathing test must show that the miner has black lung. Some doctors and most of the miners claim that this is unfair. Why? Only when the disease has become very serious does it show up on the X-rays. According to Dr. Kerr, "We've got...a lot of men who are disabled without positive X-rays (pictures that show the effects of black lung)."

The new law is not perfect, and changes are expected soon. However, the law, even as it now stands, is a step forward--even if a late step. Man has created the conditions that cause black lung disease, and only man can prevent it.

--Joan Schuman

BLACK LUNG

Questions

1) What causes black lung?

2) Why do we say black lung is an energy related health problem?

3) How does black lung affect a person?

4) Can black lung pass from one person to another like the flu?

5) What kind of workers can get black lung?

6) How does the body try to fight off black lung?

7) Why is black lung less common in England than in the United States?

8) What is now being done in the United States to help prevent black lung?

9) Why do we mine coal?

10) How many United States Coal miners out of every 100 are suspected of having black lung?

11) Why do people work in coal mines?

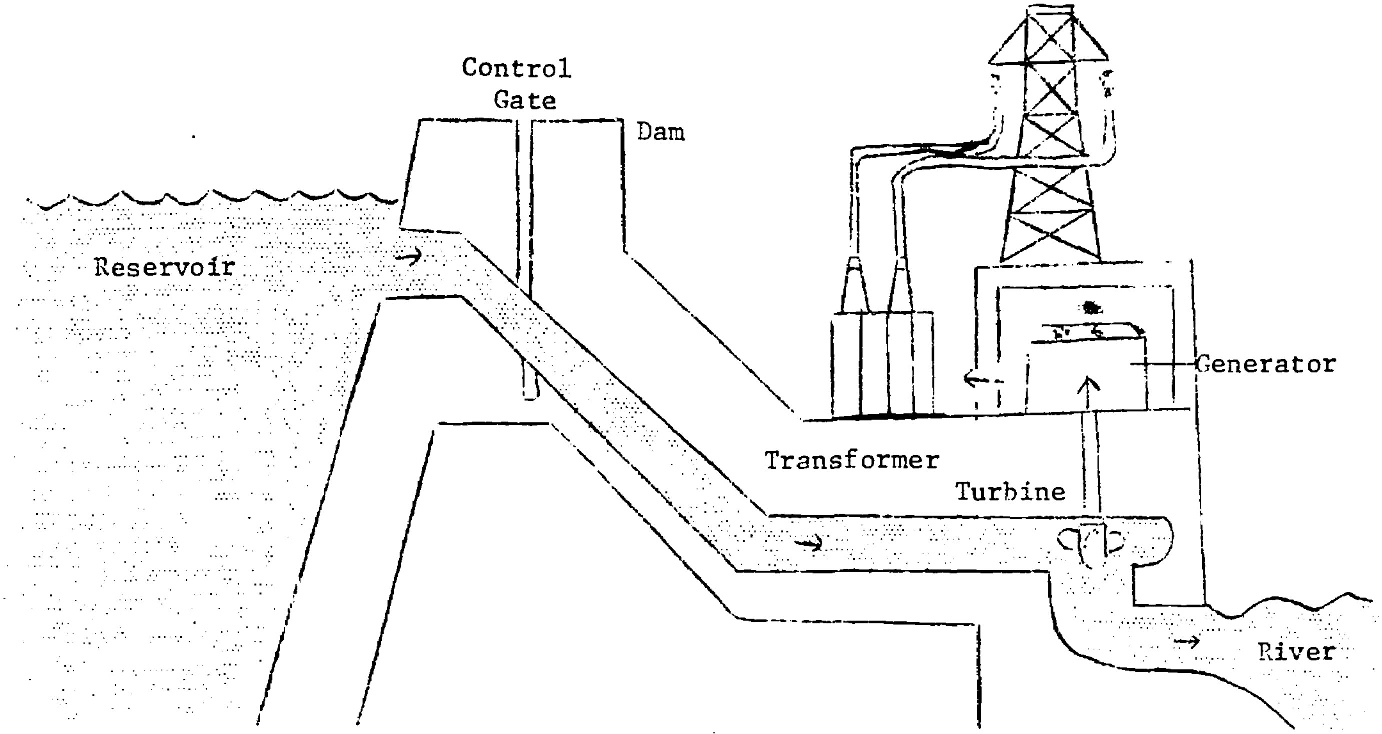
12) Do you expect coal workers in strip mines to have black lung? Why?

13) Whrre are the Appalachian Mountains located?

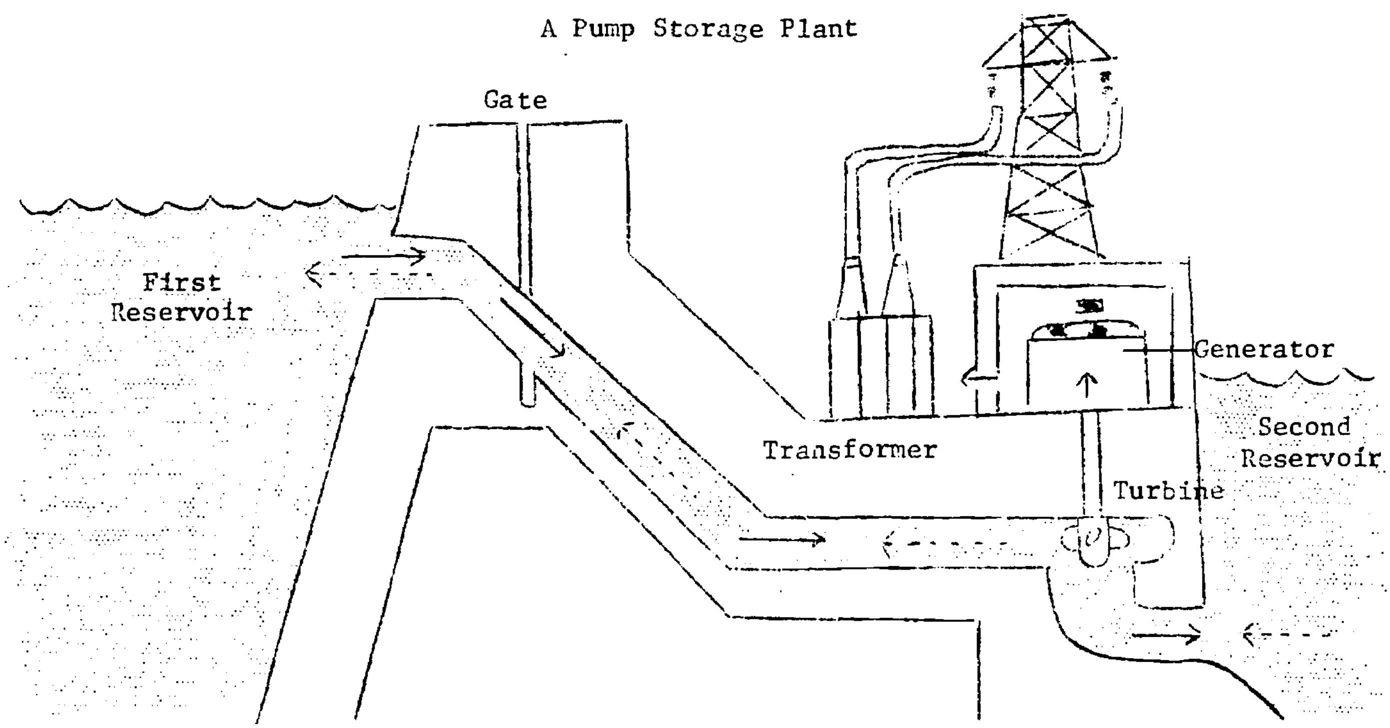
14) What is the most important action that can be taken toward controlling black lung?

HYDROELECTRIC ENERGY

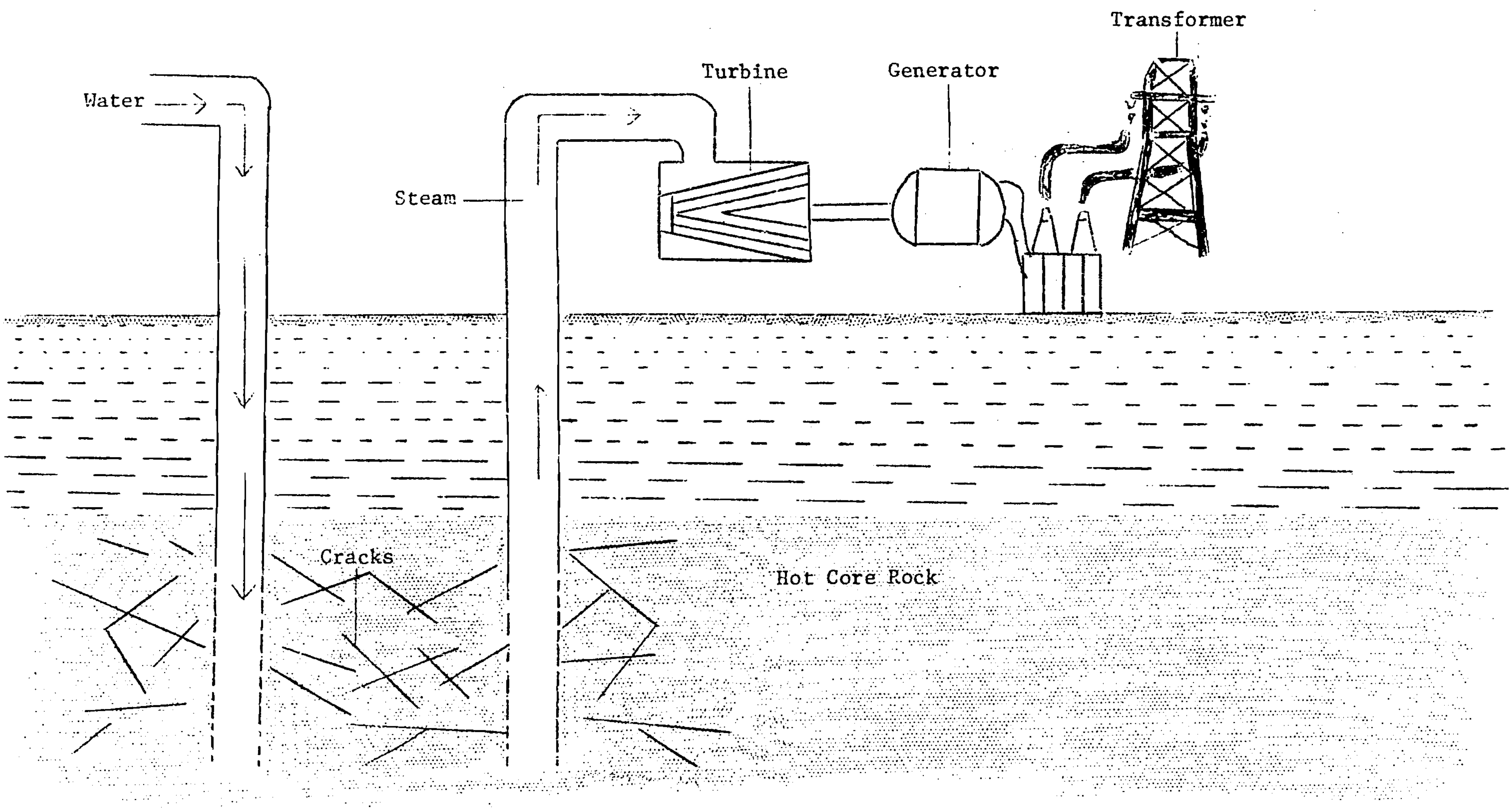
A Hydroelectric Plant



A Pump Storage Plant

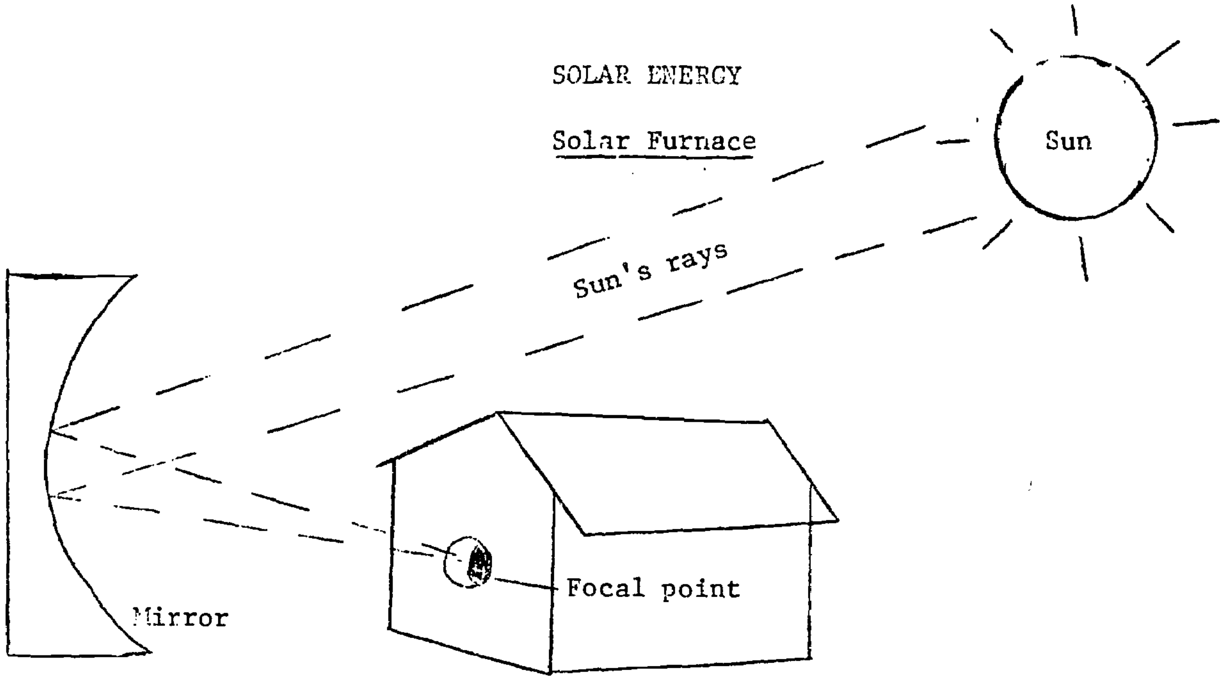


GEOTHERMAL ENERGY

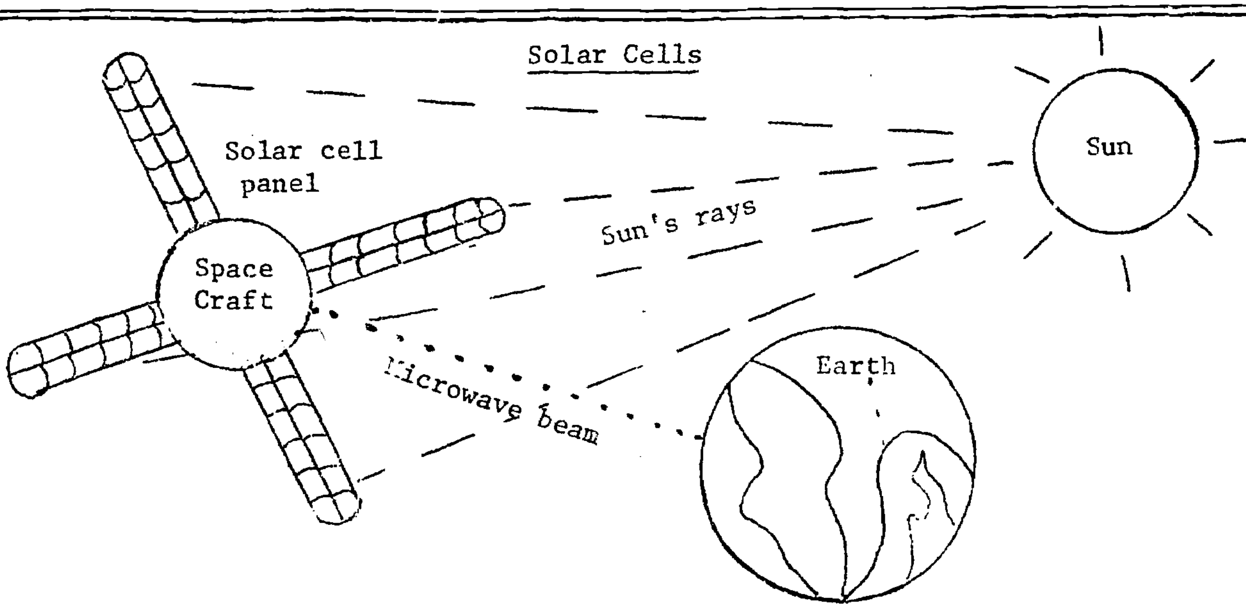


SOLAR ENERGY

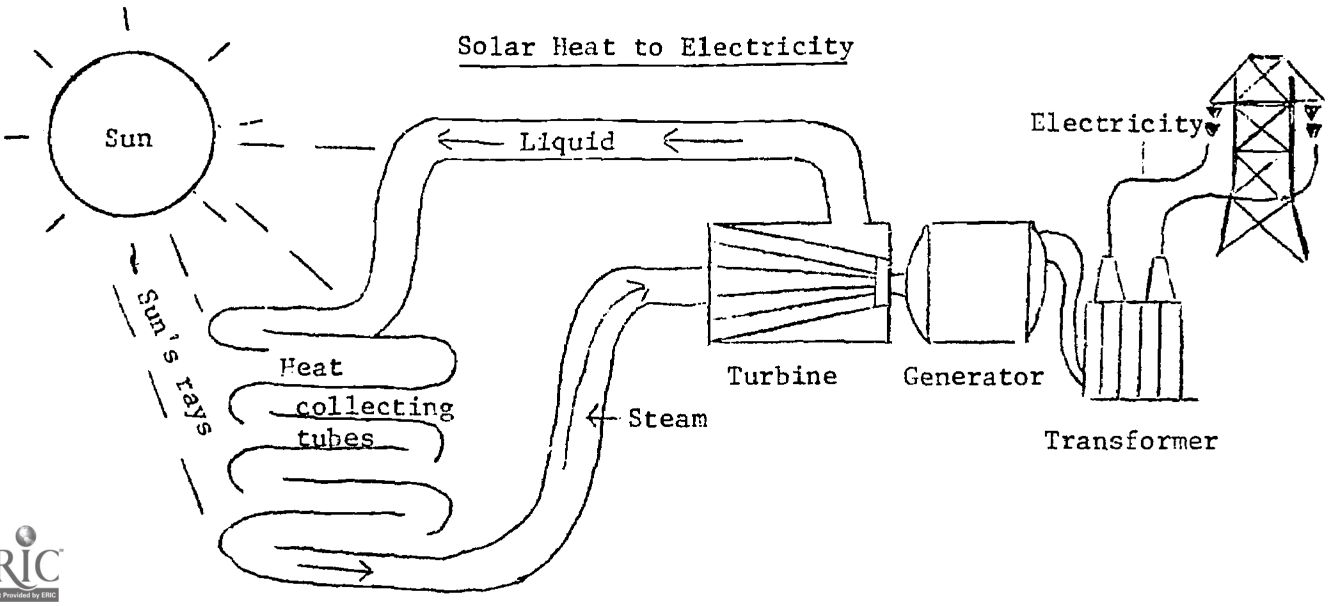
Solar Furnace



Solar Cells

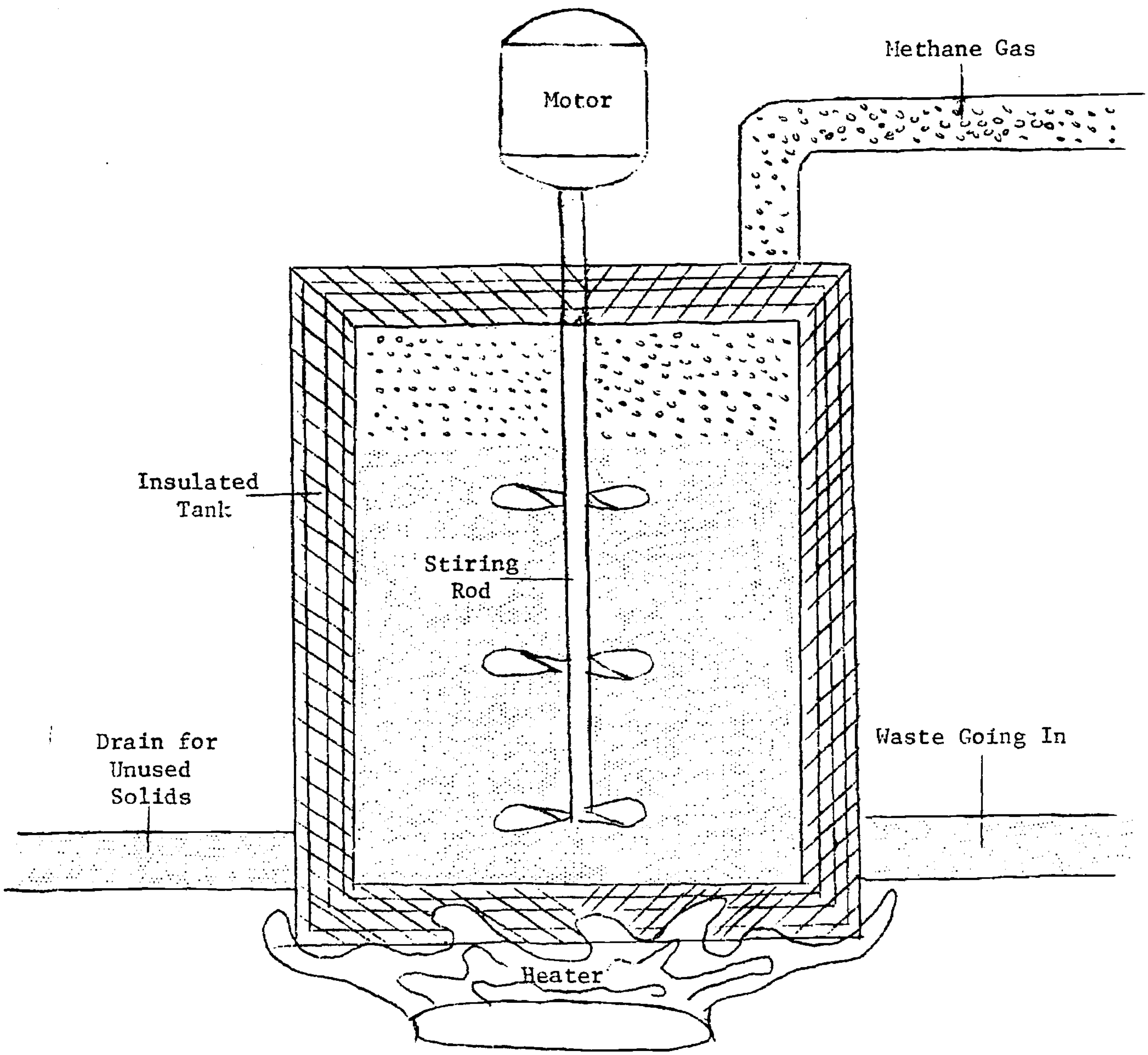


Solar Heat to Electricity

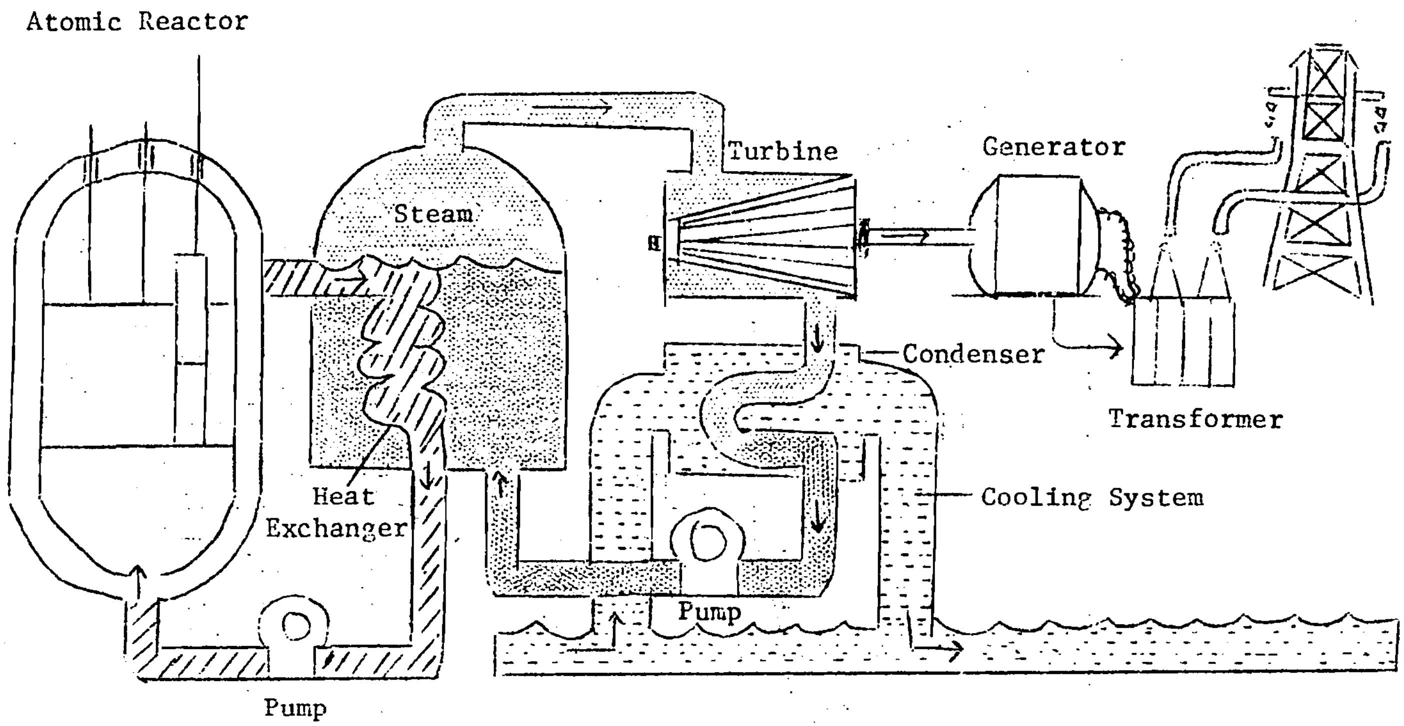


ENERGY FROM WASTE

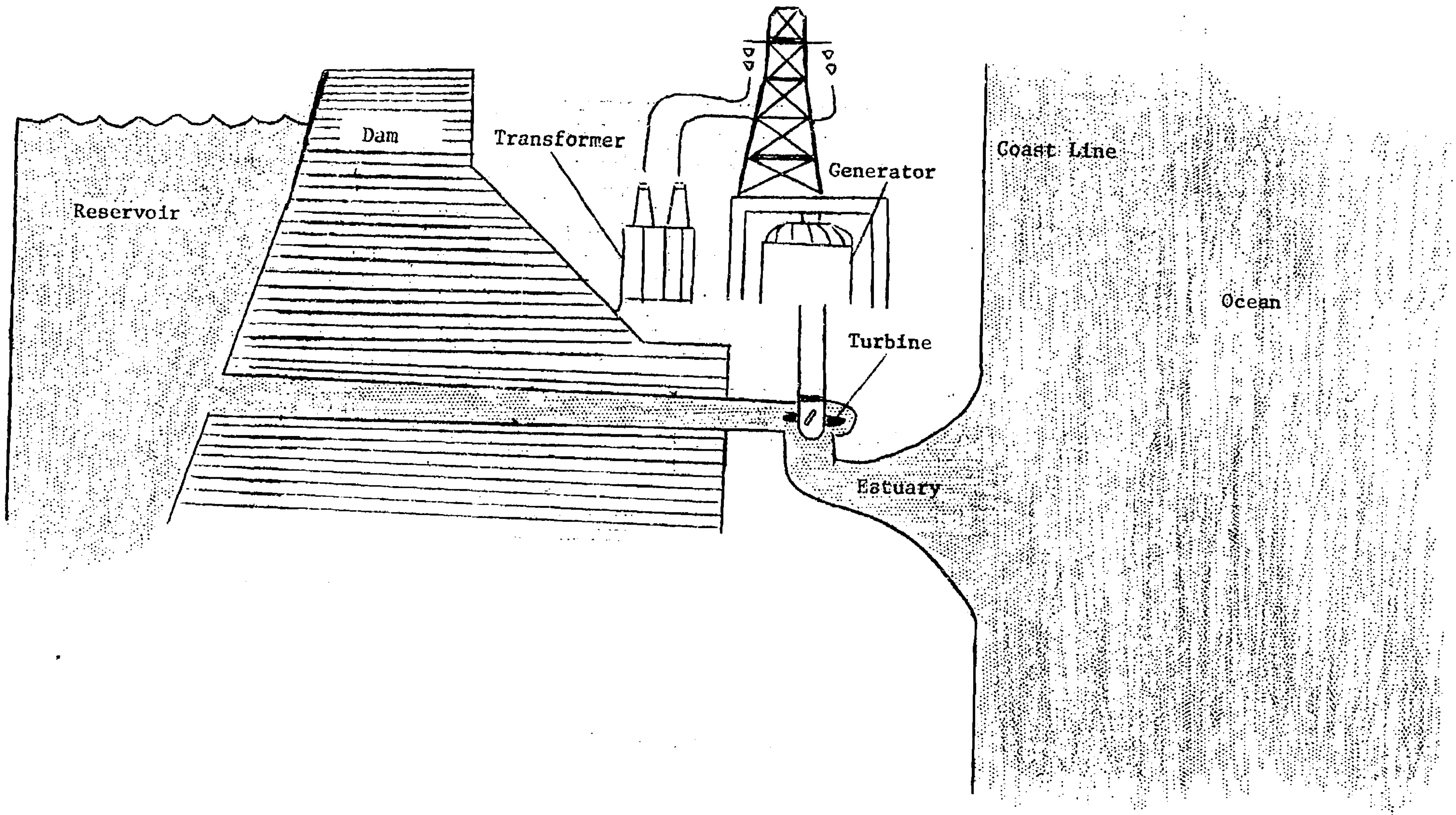
(Methane Generator)



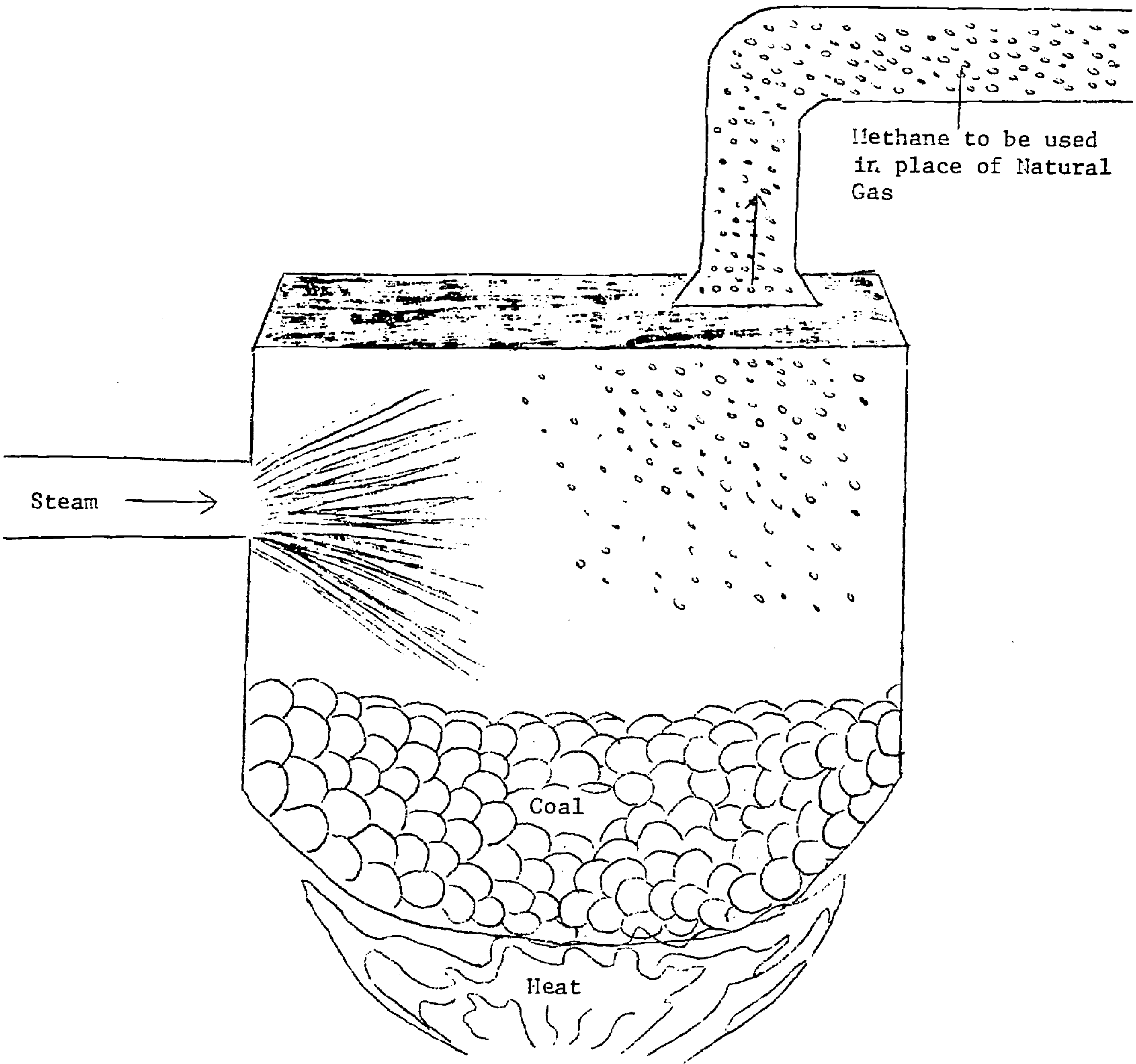
NUCLEAR POWER PLANT



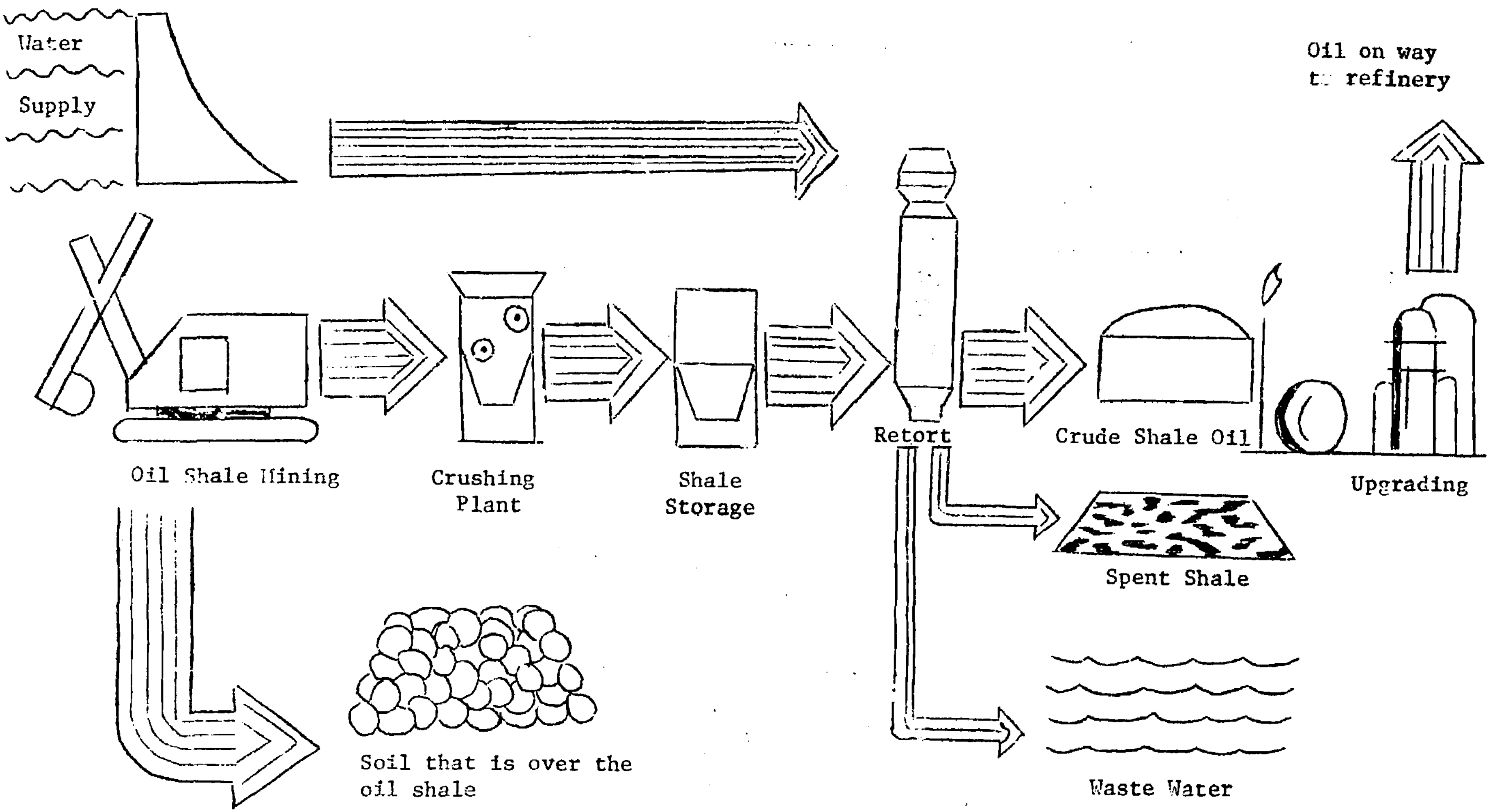
ENERGY FROM TIDES



GASIFICATION OF COAL



PROCESSING OIL FROM OIL SHALE



APPENDIX D

Tape Narrations and Film

OUR ENERGY SUPPLY

Our Energy Supply is a 20 minute, two part tape, produced by Bell and Howell as part of The Only World We Have Series narriated by Dr. Leonard Reiffel and Miss Moones.

OUR ENERGY SUPPLY - PROBLEMS (Side I)

Presents a wide variety of the problems relating to our energy usage. An attempt is made to define energy, describe our present sources, and explain the origin of our energy problem.

Discussion Questions
Side I

1) Give some examples of ways we are using energy.

2) Name something that is not using energy.

3) Could our body live without energy?

4) Why are we becoming concerned about our energy supply?

5) What are some of the sources from which we get energy?

6) Can energy be changed from one form to another without losing some of the energy?

7) What are the biggest causes of problems related to our use of energy?

8) What kind of things can happen to an area if a lake is built for generating power? Which are the benefits? Problems?

9) What are fossil fuels?

10) Where do we get fossil fuels? How?

11) About how long will our United States supply of coal last?

12) What are some sources of power other than fossil fuels?

13) How does our present population and life style affect our energy supply?

14) What does it mean to say some people are energy poor?

15) What is a calorie?

OUR ENERGY SUPPLY - SOLUTIONS (Side II)

Dr. Reiffel explains how using energy creates problems with the environment by causing various types of pollution. He sees nuclear energy as the primary solution to our future energy problems and explains the types of nuclear energy available. Other possible sources of energy are briefly examined such as tides, solar, and geothermal.

Discussion Questions
Side II

1) Is there just one answer to our energy problems?

2) Why do we need to be concerned about the environment when discussing energy?

3) What does Dr. Reiffel think our big source of energy will be in the future?

4) What does Dr. Reiffel want to do with our remaining supply of coal, oil, and natural gas?

5) Why are we not able to get more energy from hydroelectric power?

6) Where does nuclear energy come from?

7) What kind of uranium is needed for a nuclear reactor?

8) How does a breeder reactor differ from a fusion reactor?

9) What happens in a fusion reactor?

10) Which type of reaction produces the light in stars?

11) What is the big problem with using fusion reactors?

12) Where would we get the hydrogen for the fusion reactor?

13) What are some energy sources other than fossil fuels and nuclear energy?

14) How can we use geothermal energy? What produces geothermal energy?

15) How can we get energy from tides?

16) What is the big problem in using solar power?

17) Do you agree with Dr. Reiffel that nuclear energy will be our major source of energy in the future?

Film - We Use Power

11 min. - color - Churchill Films

This film is located in the Topeka Public Schools Film Library. Have your media specialist obtain it for you. Appropriate films may have been purchased since the unit was prepared so be sure and check.

The power available to past generations is compared to the power available to us today. The various forms of power are described and illustrations of how we use power today are presented. Many simple demonstrations are shown most of which students can repeat.
Caution: If students repeat the demonstration using matches, be sure they have taken precautions to prevent a fire.

The section of the film discussing electricity will be valuable in helping students understand what happens in an electrical power plant.

Questions for Discussion

1) What kind of power did early man depend on?

2) What power source did man use to assist him other than his own power in early times?

3) What are some of the ways man has used wind power?

4) What two ways has man used water power?

5) From where do most factories obtain their power?

6) Trace the changing of water power into electrical power.

7) What makes an electric motor turn?

8) What are the sources of the power used in making electricity?

9) Describe how a steam engine operates.

10) Describe how a gasoline engine operates.

11) What kind of energy do scientists think will provide our power needs in the future?

12) Name some ways your life would be different if you had only muscle power.

APPENDIX E

Field Trip Related Information

THE TOPEKA PUBLIC SCHOOLS
REQUEST TO PRINCIPAL FOR FIELD TRIP

Elementary Schools

Date Submitted_______________

Any classroom teacher who plans to take a group of students on a field trip should discuss the details of the trip with the principal of the school in advance of the date for the trip. In most cases, this planning with the principal should be done two weeks in advance of the trip. This form should be properly completed in duplicate and signed by the teacher and the principal. One copy is filed in the office of the principal and the duplicate is sent to the Office of Instruction to be filed there.

School__________________________ Grade________ Number of Pupils____________

Date of Trip__________________________ Leave__________ Return______________

Description of Trip The field trip will utilize the displays in the Kansas State Historical Society Building under the leadership of the Environmental Education Project Staff and volunteers provided by the Historical Society. The activities will be an intergal part of the energy unit developed by the Environment Education Project Staff.

Objectives of Trip

(1) To view displays illustrating the relationship between life styles and energy available to individuals.

(2) To view examples of how availability of energy changed and affected peoples lives.

(3) To view examples of how the amount of energy available to man affects how he alters his environment.

(4) To view displays illustrating energy supplies in Kansas.

Means of Transportation____

____

Required Cost Per Student None

Teacher's Signature____

= =

I approve the above request and accept responsibility for the field trip as stated in the guidelines on the reverse side.

Principal's Signature______________________________ Date_______________

FIELD TRIP GUIDELINES FOR PRINCIPALS

1. Have definite educational objectives and procedures for evaluation been established?
2. Is the field trip appropriate for the age level and/or subject area? And can it meet established objectives?
3. Are the educational outcomes commensurate with the time taken from the regular instructional program?
4. Have the students been adequately prepared to make the field trip a worthwhile experience?
5. Has the teacher made adequate arrangements at the field trip site? (Dates, time schedule, guides, safety measures, proper dress, etc.?)
6. Have any of the students within the teacher's group been denied the opportunity to participate? If so, was good judgment used in making the decision?
7. Have arrangements been made for those students who are not participating?
8. Are you aware of the length of time the students will be away from your building?
9. Does the field trip conflict with other scheduled school activities?
10. Have arrangements been made for students to be absent from other classes and to do madeup work?
11. Are substitute teachers needed?
12. Have parents been notified of the field trip and been given an oppotrunity to notify the school and ask that their child be excused from the trip?
13. Do you have on file a parent-signed pupil information record for each child giving permission for field trips (Item 164)? (Principals may wish to require signed parental permission slips for specific individual trips.)
14. Are the transportaiton arrangements adequate and safe? Are the vehicles adequately insured? (Remember that student drivers are not permitted to transport other students.)
15. Is each student required to pay a fee? If so, do you know the total charge and what expenses it covers?
16. Have you made arrangements for those students who state they cannot "afford" the field trip fee?
17. Have arrangements been made for emergency situations?
18. Has the field trip form been completed in detail and filed with the designated offices?
19. Does this field trip conflict with Topeka Plan Policy No. 11220 (1) which prohibits "the giving or attending of paid performances during the school day for which tickets will be sold or admission charged to students"? (This includes commercial movie and theatrical productions.)
20. If you have doubts concerning this trip, have you discussed them with the departmental supervisor or office of instruction?
21. Are you, as principal, "ready and willing" to accept your official responsibility for this field trip?

The Topeka Public and Parochial Schools
Unified School District No. 501
Environmental Education Demonstration Project
Phone: 232-9374

Dear Parent,

Your child will be taking a field trip to the Kansas State Historical Society Building, 10th and Jackson, on ____________________________.

Students will leave the school at _____________ and return by ________________.

The class has been studying about energy and how its usage affects our lives. On this field trip students will be observing displays illustrating different life styles and relating these life styles to the energy available to the individuals.

The field trip activities and the energy related curriculum being used in the classroom was developed by the Environmental Education Project.

You are invited to participate in this field trip as an observer. If you wish to go on the trip or have any questions, please contact me.

If you do not want your child to participate in this field trip, please contact our building principal, and your child will do alternate activities in the school.

The Topeka Public and Parochial Schools
Unified School District No. 501
Environmental Education Demonstration Project
Phone: 232-9374

Dear Parent,

Your child will be taking a field trip to the Kansas State Historical Society Building, 10th and Jackson, on ___________________________.

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The class has been studying about energy and how its usage affects our lives. On this field trip students will be observing displays illustrating different life styles and relating these life styles to the energy available to the individuals.

The field trip activities and the energy related curriculum being used in the classroom was developed by the Environmental Education Project.

You are invited to participate in this field trip as an observer. If you wish to go on the trip or have any question, please contact me.

Students will not be allowed to participate in this field trip unless this form is returned with your signature.

I give my permission for________________________________ to participate in the field trip to the State Historical Museum.

____
Parent's Signature

LEADER DIRECTIONS

During the trip to the Kansas State Historical Society, the Agricultural Hall, Indian Gallery, and fourth floor displays will be used. The major purposes will be to observe how energy demand and use changed with life style and the impact the availability of energy has on man's manipulation of his environment. Once the specific objectives for the field trip are accomplished other ideas and displays can be discussed.

Each student will have data sheets that can be completed to provide a capsule review of the field trip. The data sheets can be partially completed during or after each area is viewed. Do not have students record long answers on the data sheets, but rather use single words or short phrases.

All groups will meet together for 15 minutes in the conference room before leaving. They will have the opportunity to handle samples of energy related articles and ask questions not previously answered.

The following is a list of specific points to be discussed and/or observed at various locations during the field trip.

Agriculture Hall

1) Types of materials and energy available to the Indians farming in Kansas before the settlers.

2) Types of material and energy available to the early settlers in Kansas.

3) Energy is used in making equipment as well as in operating the equipment.

4) The influence of the Homestead Act and Railroad on the settling of Kansas.

5) Sod houses were built in western Kansas, stone houses in most of eastern Kansas. Along streams where logs were available, log cabins were constructed.

6) During the late 1800's and early 1900's the primary energy source changed from animal power to steam power, to diesel, and finally gasoline.

7) Hand operated tools gave way to electric powered tools.

8) As the source of power changed each person could control more power and thereby manipulated his environment to a greater extent.

9) As the material in the equipment changed from mostly wood to metal, the amount of energy required to make the equipment increased greatly.

10) Steam energy to operate trains not only brought settlers to Kansas but provided a way to ship cattle back east. This created the conflict between settlers and ranchers. The farmers wanted to plow and use the land to raise crops while the ranchers wanted to use the land for cattle grazing.

11) As a farmer could control more energy he was able to produce food for more people. This allowed some people to do other things such as work in factories, be artists, truckers, and etc.

Leader Directions (Continued)

Indian Gallery

1) The Early Indians life style consumed little energy because it used natural materials and mostly man power.

2) Farming Indians consumed more energy than hunting tribes because they manipulated the earth, built tools, and built more permanent homes.

3) Food energy was the primary type of energy consumed by the original Indians in Kansas.

4) Energy to power railroads and shoot guns was the primary advantage the immigrants had over the Indians.

5) More energy is required to make equipment from man made material than natural material.

Period Rooms

1) Examine the kind of energy used for heating, cooking, lighting, and operating each of the homes represented.

2) Compare energy consuming devices in the represented homes with present day homes.

3) Discuss home heating and the influence of windows and insulation.

4) Be sure students understand that the represented homes have mostly wood furniture with natural cloth covering while today's furniture is made of plastic, synthetic cloth, steel, and wood. Modern furniture consumes greater energy in its construction.

5) Compare the number and type of convenient appliances and recreational items in the represented homes with those available today.

6) Compare the teaching aids in the one room school with those in use today.

7) Bring out that as each home consumes more energy it becomes more dependent on other people, factories, power plants, and etc.

Transportation and Communication Displays

1) Discuss the type of energy used, amount and types of load it can move. Discuss the speed of each of the following: covered wagon, pony express, telegraph, train, stage coach, car, airplane, jet, and telephone.

Printing Exhibit

1) Point out that everything is hand powered.

Leader Directions (Continued)

Blacksmith Exhibit

1) All material used was either iron, steel, leather, or wood.

2) Compare the methods of working iron in the blacksmith shop with todays methods. How does the production rate and energy source differ?

Industry Displays

1) Review the location of coal in Kansas.

2) How was coal used? How is it used today?

3) Point out the locations of oil resources in Kansas. Observe differences in early drilling rigs and modern rigs.

4) Wind was at one time an important source of energy for Kansas farmers.

5) The lack of adequate transportation caused the early silk industry in Kansas to go broke.

Bison Display

The energy to power the trains into Kansas brought buffalo hunters and provided a means to ship the hides back east. This resulted in the rapid killing of the great buffalo herds.

Group Viewing of Articles in Conference Room

Students should be aware of the type of energy used to operate the article compared to its modern day replacement.

STUDENT DATA SHEET FOR ENERGY UNIT
(For use in Historical Society)

Agricultural Hall Room:

1. What were the common sources of power for the first settlers in Kansas?
____

2. What kinds of material did the early settlers have to use in building homes and equipment? ______________________________

3. What two factors were most responsible for the rapid settling of the Kansas area?
______________________________, ______________________________

4. What kinds of power were available to the Kansas farmers by early 1900?
______________, ______________, ______________

5. By the 1930's what kinds of power were available to most farmers? __________
__________ __________ __________ __________

6. How did the size of farms change with the availability of more power?__________
____

7. How was the farm equipment used in the middle 1900's different than the equipment used in the middle 1800's? ______________________________
____

8. What brought about the conflict between settlers and ranchers?______________
______________. How did energy availability enter into this conflict?
____

Indian Gallery:

1. What kinds of material did the Indians (living in Kansas before the settlers) have available to use in making tools and homes?______________________________

2. What was the source of energy used in making these tools and homes? __________
______________Which kinds of homes required the most energy to build?
____

3. What kinds of energy were used in obtaining their food supply? ______________
____

4. What kinds of energy did the early settlers have that was not available to the Indians?______________________________

5. How has the type of materials used changed over the last 100 years? __________
______________ How do these changes affect energy needs?
____

Period Rooms:

1. What kind of energy was used in the sod house to provide light? ______________
______________ To provide heat? ______________

2. What kinds of energy was required to make items in the sod house? __________
____

Student Data Sheet for Energy Unit (Continued)

3. What kind of energy provided light in the Victorian Home? ____________________ ____________________ Provided the heat? ____________________

4. What kind of power was used to operate the equipment in the period rooms? ______ ____________________

5. How has the building of homes changed to improve their use of the energy available? ____________________

6. What kind of heating and lighting were used in the one room school house?_____ ____________________

7. What are examples of energy users in our homes that were not present in the home represented by the 1859 bedroom? ____________________ ____________________

8. What are some examples of energy using equipment available in the present day schoolroom that were not available in the one-room school?____________________ ____________________

9. What kinds of material was used in constructing house furniture before 1940? _ ____________________

10. How did the number of household appliances change between the sod house life-style and the following wood frame house life-style? ____________________ Was there more energy required to manufacture the appliances for the second life-style? ____________________

Fourth Floor Exhibits:

1. Compare the stage coach, car, and airplane: Which one is able to move people the fastest? ____________________ What kind of energy does each require? ____________________

2. How does working and shaping metal today differ from the methods used in early 1900's? ____________________

3. Where are most coal supplies found in Kansas? ____________________

4. When was oil first discovered in Kansas? ____________________

5. Why did coal loose its importance as a source of energy in Kansas during the last two decades? ____________________ ____________________

6. Why did the early attempt to establish a silk industry in Kansas fail? _______ ____________________ ____________________

TEACHER GUIDE FOR FIELD TRIP DISCUSSION

Upon returning from the field trip be sure the students have an opportunity to discuss the data they have collected along with other comments they have regarding the field trip.

Review how their life-style is different from their grandparents, and how it differs from earlier peoples. Relate kinds and amounts of energy used with each type of life-style.

Refer back to the information on life-styles in Topic V. By again looking at this data the students may better be able to understand the different energy demands for each life-style.

By thinking about their Home Energy Usage Checklist they can compare their energy demands with those of the life-styles represented by the exhibits viewed during the field trip.

Allow the students to discuss the pros and cons of reducing our energy demands by going back to some of these earlier life-styles. Do the students see any examples from other life-styles they are willing to adopt that will reduce energy demands?

Have the students discuss: Does life-style change first, or does the energy become available first? How will our life-style change as energy becomes harder to obtain? Does the size of our population affect the type of life-style we can have?

Have the students discuss that when more energy is available the more diversity there is in a countries economy. This can easily be related to the decreasing proportion of the United States population that is involved in farming and the large variety of businesses and industry we have.